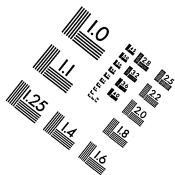
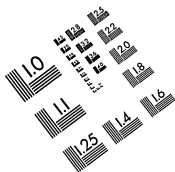


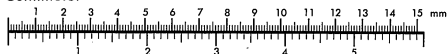


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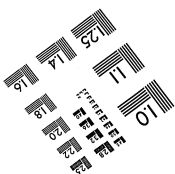
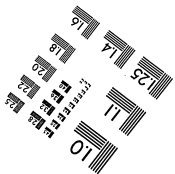
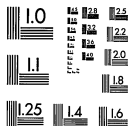
MS303-1980



Centimeter



Inches



Thomas A Edison Papers

A SELECTIVE MICROFILM EDITION

PART I
(1850-1878)

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Frederick, Maryland
1985

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START

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A Note on the Sources

The pages which were microfilmed for this collection are in generally good condition in the original. There are some pages, however, which due to age are lighter than normal. Additionally, because some volumes are very large and have been bound tightly and cannot be unbound, there are intermittent occurrences of slight distortion of the edges of a small percentage of the pages. We have made every technical effort to ensure complete legibility of each and every page.

TELEPHONE INTERFERENCES

The Edison National Historic Site has seven bound volumes and one pamphlet of Patent Office proceedings relating to conflicting claims over who invented the telephone.

Four of these volumes contain the record of a group of interferences entitled Cases A through L and Case No. 1. The disputant parties were Thomas Edison, Alexander Graham Bell, Elisha Gray, A.E. Dolbear, J.W. McDonough, George B. Richmond, William L. Voelker, J.H. Irwin, and Francis Blake, Jr. Although Edison's preliminary statements were filed in September 1878, testimony was not taken until 1880. This record was printed in 1881.

The first volume contains Edison's preliminary statements and the depositions of Edison and his witnesses. The second volume contains Edison's exhibits, including photo-lithographs of laboratory drawings, patents and patent applications, and newspaper and journal articles. The drawings have exhibit numbers corresponding to a page/volume numbering scheme used by Edison and his patent attorney Lemuel W. Serrell in 1880 when Edison's technical notes and drawings were numbered and examined for possible inclusion as exhibits in these interferences. Many of the documents in this numbered series were not selected as exhibits; they remain in the archive at ENHS. (See Unbound Notebooks, Volumes 8-18.)

In addition to the two volumes of testimony and exhibits for Edison, there is a third volume, containing preliminary statements, depositions, and exhibits for Bell, Voelker, Irwin, Gray, Dolbear, McDonough, and Blake; and a fourth volume, containing briefs for Bell and Blake by attorneys Chauncey Smith and James J. Storrow.

Only the two Edison volumes have been filmed in their entirety. However, the tables of contents for the other two volumes have been filmed, along with those portions of the briefs for Bell and Blake which summarize the issues and Edison's case from the viewpoint of the opposing attorneys.

Another volume entitled U.S. Patent Office, Miscellaneous Interferences of T.A. Edison contains four documents relating to appeals taken in 1883-1884. Three of these documents are briefs for Edison; the fourth is the decision of the Examiners-in-Chief in the appeal of Cases A, B, C, D, E, F, G, I, J, L, and No. 1.

Two additional volumes contain the records of interference cases 2 and 3 (involving Edison, Blake, and Charles E. Chinnock) and cases 4, 5, 6, and B³ (involving Edison, Blake, and Edward L. Wilson). Each volume contains the preliminary statements, interfering specifications, and evidence of the disputant parties. The table of contents, preliminary statements, and interfering specifications for each volume have been filmed, as well as the evidence for Edison. The numbering system used in Cases A through L and Case No. 1 was also employed for Edison's exhibits in these cases. Many of the exhibits were also used in the earlier volume

of Edison's exhibits; these have not been refilmed. However, the complete list of Edison's exhibits for the later interferences can be found in the table of contents.

Finally, there is a printed argument for Edison in a telephone interference involving Edison, Amos E. Dolbear, and George L. Anders. This is the only documentation for this interference available at the Edison National Historic Site.

The volumes have been filmed in the following order:

1. Evidence for Thomas A. Edison
2. Edison Exhibits
3. Evidence for Voelker, Irwin, Gray, McDonough, Blake and Bell
4. Briefs for Alexander Graham Bell and Francis Blake, Jr.
5. Miscellaneous Interferences [briefs for Edison and decision in appeals, 1883-1884]
6. Cases 2 and 3
7. Cases 4, 5, 6, and B³
8. Edison v. Dolbear v. Anders [argument for Edison]

Telephone Interferences [Volume 1]

Evidence for Thomas A. Edison

This volume has been filmed in its entirety.

THE
SPEAKING TELEPHONE
INTERFERENCES.

Edison, Bell, Gray, and Others.	Cases A. to L. and No. 1.
---------------------------------------	---------------------------------

EVIDENCE FOR THOMAS A. EDISON.

VOL. 1.

LEMUEL W. SEIDELL,

FOR EDISON.

The Speaking Telephone Interferences

United States Patent Office.

THOMAS A. EDISON.
A. G. BELL.
ELISHA GRAY.
A. E. DOLBEAR.
J. W. McDONOUGH.
G. B. RICHMOND.
W. L. VOELKEL.
J. H. IRWIN.
FRANCIS BLAKE JR.

CASES A TO L
AND No 1.

Vol. I.

Evidence on behalf of THOMAS A. EDISON.

LEONARD W. SERRILL,
New York
for Editor.

621.385008
5

EDISON'S RECORD.

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ERRATA.

PAGE

7. "of the" should be omitted in 7th line.
10. 1st line, "object" for "objecta."
20. Folio 84, "faults" should read "parts."
31. Folio 13, for "parried" read "parried."
44. 17th line, space between "fell" and "rest
ing."
44. 18th line, space between "metallic" and
"surface."
63. 39th line, for "adjustable" read "adjustable."
74. 23d line, for "like" read "is."
75. 24th line, for "diaphragm" read "diaphragm."
77. 4th and 5th line, for *Edison's Exhibit in-
strument*, 0-11," read "*Edison's Exhibit*
30-11."
103. Line 9 and 10, read 130-11 for 131-11.
112. In x-Q, 188, insert *l.* after "electrode."
112. In x-Q, 191, for "armature" read "arma-
ture."
120. Last line, for "called" read "called."

United States Patent Office.

A. G. BELL.
ELISHA GRAY
THOS. A. EDISON
B. BRILINKER
GEO. B. RICHMOND
A. E. DOLEBEAR
J. W. McDONOUGH
W. L. VOELKER.

TELEPHONE INTERFERENCE,
A, B, C, D, E, F, G, I, J, L, M.

PRESENT PARTIES TO THESE SEVERAL INTERFERENCE.

[JAN. 1, 1881.]

A. G. BELL. — (*A. Pellot, Washington, D. C., Attorney of Record.*)

Patent No. 174,405, March 7, 1876.

Patent No. 180,787, Jan. 30, 1877.

ELISHA GRAY. — (*Bethwin, Hopkins & Peyton, Washington, D. C.,*

Attorneys of Record.)

Application No. 1, filed Oct. 29, 1877.

Application No. 2, filed Oct. 29, 1877. Model filed Dec. 4, 1877.

" No. 3, " " " " " " " " " "

Application No. 4, filed Jan. 17, 1878.

THOMAS A. EDISON. — (*L. W. Serrell, New York, Attorney of Record.*)

Application No. 130, filed April 27, 1877.

" " 141, " July 20, 1877.

" " 144, " Sept. 5, 1877.

" " 145, " Dec. 18, 1877.

" " 148, " Dec. 24, 1877.

EMILE BERLINER. — (*A. Pollok, Washington, D. C., Attorney of Record.*)

Application filed June 4, 1877.

GEO. B. RICHMOND. — (*Geo. W. Dyer, Washington, D. C., Attorney of Record.*)

Application filed Aug. 24, 1877.

A. E. DOLBEAR. — (*F. L. Pope, 33 Park Place, N. Y., Attorney of Record; J. L. Norris, Washington, D. O., Associate.*)

Application filed Oct. 31, 1877.

J. W. McDONOUGH. — (*Griffley & Co., Chicago, Ill., Attorneys of Record.*)

Application filed April 10, 1878.

W. L. VOELKER. — (*R. D. O. Smith, Washington, D. C., Attorney of Record.*)

Application filed May 19, 1879.

These interferences were declared by office letter of March 26, 1878. By office letter of May 1, 1879, award of priority was made against Richmond upon his own statement in cases A, B, D, E, G, and J; he was continued in case C. Said interferences were revised and consolidated by office letter of May 27, 1879, in consequence of the decision of the Commissioner reported in the *Official Gazette* of May 13, 1879, as Gray *et al.* v. Bell, whereby case H was consolidated with and to be known as case F, and K and I as I. By office letter of July 29, 1879, priority of invention was awarded against Holcombe, and he was dropped from A, E, F, G, I, J. By office letter of Dec. 29, 1879, W. L. Voelker was included in interferences A and B. E. Berliner was originally included in A and B, and was dropped therefrom by office letter of Sept. 3, 1880, upon concession filed by him in favor of Bell; he continues in M. Richmond took no proof.

SUBJECT-MATTER.

INTERFERENCE A.

Voelker v. Dolbear v. Gray (1) v. Edison (180) v. Bell (174,465).

"The heretofore-described art of transmitting and reproducing at a distance sonorous waves or vibrations of any description, which consists in increasing and decreasing the strength of an electric cur-

rent traversing a circuit in such a manner as to produce in said circuit a series of electrical waves or vibrations, precisely corresponding in their intervals of succession and relative amplitudes to the sonorous waves which are to be reproduced at the receiving station or stations, so that oral conversations or sounds of any description may be telegraphically transmitted." [Gray's 1st claim.]

This is substantially the method specified in Bell's fifth claim, and is described in the applications of Edison, Dolbear and Voelker.

INTERFERENCE B.

Voelker v. Gray (1) v. Edison (180) v. Bell (174,465).

"The heretofore-described improvement in the art of transmitting vocal sounds or spoken words telegraphically, which consists in throwing upon the line through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air produced by a spoken word." [Gray's 2d claim.]

This is substantially described in the applications of Bell and Edison. Voelker's 1st claim.

INTERFERENCE C.

Gray (2) v. Edison (144) v. Richmond v. Bell (174,465).

"1st. The transmitter consisting of the combination in an electric circuit of a diaphragm and a liquid or equivalent substance of high resistance whereby the vibrations of the diaphragm cause variations in the resistance of the electric circuit, and consequently in the strength of current traversing said circuit." [Gray's 1st claim.] This is described in the applications of Edison and Richmond, and patent of Bell.

"2d. In a telegraph instrument operated by sound, the combination with the diaphragm of two or more electrodes placed in electrolytic liquid and operating to increase and decrease the resistance of the electric circuit by the movement derived from the diaphragm." [Edison's 1st claim.]

This is described in the applications of Richmond and Gray, and is substantially suggested in Bell's patent.

INTERFERENCE D.

Gray (2) v. Edison (144).

"In an electro-hydro telephones, the fluid-holding vertically adjustable tube, within which the ends of the platinum points are immersed, as set forth." Substantially described and shown in Edison's application (No. 144), and described in Gray (2).

INTERFERENCE E.

Edison (145) v. Gray (3) v. Dolbear v. Bell (174,465).

"In an acoustic telegraph, an armature plate, the electro-magnet for the same, and a closed circuit passing from the helix of such electro-magnet to the source of undulatory electric energy."

This is the subject-matter of Edison's third claim, and is substantially described in the other applications and the patent involved.

INTERFERENCE F.

Dolbear v. Gray (1) v. Bell (174,465).

1st. "A telephonic transmitter consisting of a coil of wire, one or more magnets and a disk, or diaphragm so arranged relative to each other that a motion of the diaphragm shall induce in the coil of wire an electric motive force in virtue of the presence of the magnet or magnets."

This is substantially described and shown in applications of Dolbear and Gray, and patent of Bell.

2d. [Formerly II.] "The combination in one circuit of two or more coils of wire, two or more magnets, and two or more disks or diaphragms, so arranged relative to each other that if one of the disks or diaphragms be put in motion by the voice, by a current of air or otherwise, it shall induce a transient current of electricity in its associated coil, which current shall actuate the other disks or diaphragms in virtue of the coil and magnets associated with them." This is described and shown in applications of Dolbear and Gray, and patent of Bell.

INTERFERENCE G.

Edison (148) v. Gray (3) v. Dolbear v. McDonough v. Bell (174,465).

"A telephonic receiver consisting of the combination in an electric circuit of a magnet, and a diaphragm supported and arranged in close proximity thereto, whereby sounds thereon upon the line may be reproduced accurately as to pitch and quality." [Substantially Gray's claim.]

This is substantially described or shown in the applications of Dolbear, Edison and McDonough, and in patent of Bell.

INTERFERENCE I.

Dolbear v. Gray (3) v. Bell (186,787).

1st. "A telephonic transmitter consisting of one or more helices, forming a portion of the main circuit, and surrounding a core or cores maintained in a magnetic state by the inductive influence either of an electric current or of a permanent magnet in combination with an elastic inductive plate or armature, which is rigidly supported at one or more of its edges, while the portion facing the poles of the magnetic core or cores is left free, so as to be capable of responding to sonorous vibrations traversing the atmosphere or other bodies."

This is substantially Dolbear's first claim, and is substantially embraced in Bell's third and eighth claims. It is described in application of Gray.

2d. [Formerly K.] "Two iron or steel cores respectively mounted upon the opposite poles of a permanent magnet receiving magnetism therefrom by induction, and provided with enveloping helices of insulated wire, which form a portion of the main circuit in combination with an elastic inductive plate or armature rigidly supported at one or more of its edges, while the portion thereof facing the poles of the magnetic cores is free, so as to be capable of responding either to sonorous vibrations traversing the atmosphere or other

bodies, or to magneto-electric pulsations or undulations traversing the helices surrounding the magnetic cores." [Dolbear's 2d claim.] This is described and shown in Bell's patent.

INTERFERENCE J.

Edison (148) v. Gray (3) v. Dolbear v. Bell (186,787).

"The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for rendering audible vibration." [Edison's 1st claim.]

This is substantially embraced in Bell's third claim and Dolbear's third claim, and described in application of Gray.

INTERFERENCE L.

Gray (4) v. Edison (145) v. Bell (174,465).

1st. The combination in an acoustic telegraph of an electro-magnet, and a polarized armature formed of a plate of iron, steel, or other material capable of inductive action, and a resonant tube or case. [Edison's 1st claim.]

2d. The combination in an acoustic telegraph of an armature plate polarized by induction, a resonant case or tube, and an electro-magnet and circuit connections whereby reverse currents are caused to act in the electro-magnet with varying intensity proportionate to the electric waves sent from the transmitting station. [Edison's 2d claim.]

This subject-matter is described and shown in the applications of Bell and Gray.

INTERFERENCE M.

Edison (141) v. Berliner.

In a telegraphic apparatus operated by sound the combination with the diaphragm of one or more contact points of plumbago or similar inferior conductor in the electric circuit whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm. [Edison's 3d claim.]

This is described and shown in Berliner's application.

INTERFERENCE No. 1.

Edison—Blake—Irwin—Voelkers.

A spring, for holding or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes, and yield to the movement of the diaphragm (Blake's claim).

This is substantially claimed by Irwin (claim 7), and is described or shown in the applications of the other parties.

IN THE MATTER OF INTERFERENCE ON TELEPHONES.

Voelkers.	} Case No. 1.	Voelkers	} Case A & B
Irwin.		Dolbear	
Blake.		Gray	
Edison.		Berliner Edison Bell.	

PHILADELPHIA, March 13, 1880.

It is stipulated in the above interference that case No. 1 is to fall behind cases A and B in the dates for the taking of testimony and the hearing, and that Edison may take his testimony in all of these cases at the same time, and that at the hearing the testimony in all these cases, and the Exhibits, may be used in each case by any party to any of said cases.

GEO. W. DYER,

For Voelkers and Irwin.

JAMES J. STORROW,

Counsel for Berliner, Blake & Bell.

BALDWIN, HOPKINS & PEYTON,

Attorneys for Gray.

LEMUEL W. SERRELL,

Attorney for Edison et al.

FRANK L. POPE,

Attorney for Dolbear.

IN THE UNITED STATES PATENT OFFICE.

In the Matter of Interference.
THOMAS A. EDISON, Interfer-
ence A, Case 120,

vs.

ELISHA GRAY, EMILE BELLIERE,
GEO. D. ROBERTS, A. E. DOE-
REAU, A. G. HOLCOMBE, A.
G. DEAL.

SPEAKING TELEGRAPH.

PRELIMINARY STATEMENT OF THOMAS A.
EDISON.

[Interference A.]

(Filed September 28th, 1878.)

City, County and State } ss.
of New York,

THOMAS A. EDISON, being duly sworn, deposes and
says: I conceived apparatus for carrying out the inven-
tion in question as early as February, 1878.

I obtained Letters Patent, No. 141,777, dated August
15th, 1878, which contained a device for transmitting
waves of varying intensity over or within a closed cir-
cuit containing an electro magnet. I conceived the idea
of employing this apparatus in conjunction with a dis-
turbance in July, 1878; constructed apparatus to carry

out the conception between July, 1875, and December, 1875, both with tuning forks, reeds and diaphragms, for transmitting sonorous vibrations. It was exhibited to many persons between August, 1875, and December, 1875, and since.

THOMAS A. EDISON.

Sworn to and subscribed before me, this 25th day of September, A. D. 1878.

[SEAL] GEO. T. FROCKNEY,
Notary Public,
Kings Co.

Approved May, 1, 1879.

WILBIE.

IN THE UNITED STATES PATENT OFFICE

In the Matter of Interference.
THOMAS A. EDISON, Interfer-
ence B, Case No. 130,

vs.

ELISHA GRAY, EMILIE DEBRUNER,
GEO. B. RICHMOND, A. G.
BELL,

PRELIMINARY STATEMENT OF THOMAS A.
EDISON.

[Interference B.]

(Filed September 28, 1878.)

City, County and State of New York,

THOMAS A. EDISON, being duly sworn, deposes and says, that I conceived the apparatus for carrying out the invention in question as early as February, 1873. I obtained Letters Patent, No. 141,777, dated August 12, 1873, which contained a device for transmitting waves of varying intensity over or within a closed circuit containing an electro magnet.

I conceived the idea of employing this apparatus in conjunction with a diaphragm in July, 1875; constructed apparatus to carry out the conception between July, 1875, and December, 1875, both with tuning forks, reeds and diaphragms for transmitting sonorous vibrations.

It was exhibited to many persons between August, 1875, and December, 1875, and since.

THOMAS A. EDISON.

Sworn to and subscribed before me, this 25th day of September, A. D. 1878.

[SEAL] GEORGE T. PIERCKNEY,
Notary Public,
Kings Co.

Approved May 1, 1879.
WILBER.

IN THE UNITED STATES PATENT OFFICE.

In the Matter of Interference.
THOMAS A. EDISON, Interfer-
ence C, case No. 144,

vs.

ELISHA CHAY, G. B. RICHMOND,
and A. G. BULL.

SPEAKING TELEGRAPH.

PRELIMINARY STATEMENT OF THOMAS A.
EDISON.

(Interference C.)

(Filed Sept. 28, 1878.)

City, County and State of New York, ss.:

THOMAS A. EDISON, being duly sworn, deposes and says, that the instrument in which two or more pairs of

electrodes were placed in an electrolytic liquid and used with a diaphragm to increase or decrease the resistance of the circuit, was conceived some time in August, 1876.

THOMAS A. EDISON.

Sworn to and subscribed before me }
this 25th day of September, }
A. D. 1878.

GEO. T. PIERCKNEY,
Notary Public,
Kings Co.

Approved
May 1, 1879.
WILBER.

IN THE UNITED STATES PATENT OFFICE

In the Matter of Interference.
THOMAS A. EDISON, Interfer-
ence D, case No. 144,

vs.

GEORGE B. REIDMOND, ELISHA
GRAY.

PRELIMINARY STATEMENT OF THOMAS A.
EDISON.

SPEAKING TELEGRAPHS.

(Interference D)

(Filed Sept. 28, 1878.)

City, County and State of New York, ss.:

THOMAS A. EDISON, being duly sworn, deposes and says, that in Letters Patent No. 141,777, dated August 12, 1878, are shown the main features involved in the present interference. In this patent is shown the vibrating point, coil, water and adjustment, and the vibration of the point within the coil produced a rise and fall of tension within a closed circuit containing an electro magnet. In July, 1875, I conceived the idea of employing these devices with a diaphragm; made experiments with apparatus embodying this principle during the latter part of the year 1875 with tuning forks and diaphragms. In May, 1876, further operative instruments were made; and from that time down to the present extended tests

have been made to reduce the invention to the most available form for practical use.

THOMAS A. EDISON.

Sworn to and subscribed before me []
this 28th day of September, 1878. []

Geo. T. PINESEY,
(SEAL.) Notary Public,
Kings Co.

Approved May 1, 1879.
WILDER.

IN THE UNITED STATES PATENT OFFICE.

In the Matter of Interference.
THOMAS A. EDISON, Interfer-
ence E, Case No. 145,

vs.

A. E. DOLEMAN, Geo. B. REID-
MOND, E. GRAY, A. G. BELL,
and A. G. HOLECOMBE.

AUSTRIAN TELEGRAPHS.

PRELIMINARY STATEMENT OF THOMAS A.
EDISON.

[Interference E.]

(Filed September 28, 1878.)

City, County and State of New York, ss.:

THOMAS A. EDISON, being duly sworn, deposes and says, that I conceived the apparatus in question about

September, 1875; I constructed and operated an instrument of this kind some time in September, 1875; I prepared a caveat December 25, 1875, which contains a full description of the apparatus. This caveat was filed some time in January, 1876. Apparatus embodying the invention in question has been constructed by me and publicly introduced since the preparation of the caveat papers.

THOMAS A. EDISON.

Sworn to and subscribed before
me, this 25th day of September,
A. D. 1878.

Geo. T. PINEKEY,
Notary Public,
Kinds Co.

Approved May 1, 1879.

WILBIE.

IN THE UNITED STATES PATENT OFFICE.

In the Matter of Interference.

THOMAS A. EDISON, "G," case
No. 148,

vs.

ELBERTA GRAY, Geo. B. RICH-
MOND, A. E. DOLBERG, A. G.
HOLCOMB, JAMES H. McDON-
OUGH, A. G. BELL.

ACROBATIC TELEGRAPHY.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

[Interference G.]

(Filed Sept. 28, 1878.)

City, County and State of New York, ss.:

THOMAS A. EDISON, being duly sworn, deposes and says, that I conceived the apparatus in question about November 1, 1875; I constructed three receiving telephones December 20, 1875; I put them in practical operation on the same date (December 20, 1875), and the same have been in public use ever since; these instruments were seen in operation by many persons

within a few days after they were constructed, and have been used in giving public exhibitions.

THOMAS A. EDISON.

Sworn to and subscribed before }
me, this 25th day of September, }
A. D. 1878.

Geo. T. PINKNEY,
Notary Public,
Kings Co.

Approved May 1, 1879.
WILMER.

IN THE UNITED STATES PATENT OFFICE.

IN THE MATTER of Interference Thomas A. Edison Interference J., Case, No. 148,

vs

J. B. Richmond, A. E. Dolbear, Elihu Gray, A. G. Hickombe, A. G. Bell.

ACOUSTIC TELEGRAPHS.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

[*Interference J.*]

(Filed September 20, 1878.)

City, County and State of New York, ss.:

Thomas A. Edison, being duly sworn, deposes and says, that I conceived the apparatus in question about

November 1, 1875. I constructed three receiving telephones, with an iron diaphragm secured to a resonant case, in front of which was an electro-magnet, December 20, 1875.

I put them in practical operation December 20, 1875, and the same have been in public use ever since.

These instruments were soon in operation by many persons within a few days after they were constructed, and they have been used in giving public exhibitions.

THOMAS A. EDISON.

Sworn to and subscribed }
before me, this 25th }
day of Sept., A. D. 1878. }

GEORGE T. PINKNEY,
Notary Public,
Kings County.

Approved May 1, 1879.
WILMER.

IN THE UNITED STATES PATENT OFFICE.

IN THE MATTER of Inter-
ference THOMAS A. EDISON.—L.
Case, No. 145,
ss.

A. G. BELL, ELISHA GRAY.

ACQUINTO TELEGRAPHS.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

[Interference L.]

(Filed September 28, 1878.)

City, County and State of New York, ss.:

Thomas A. Edison, being duly sworn, deposes and says, that I conceived the apparatus in question about September, 1875. I constructed and operated an instrument of this kind sometime in September, 1875. I wrote a caveat December 25, 1875, which contains a full description of the apparatus. This caveat was filed some time in January, 1876. Apparatus embodying the in-

vention in question has been constructed by me and publicly introduced since the date of the caveat.

THOMAS A. EDISON.

Sworn to and Subscribed be-
fore me, this 29th day of }
Sept., A. D., 1878.

GEORGE T. PINCKNEY,
Notary Public,
Kings County.

Approved—May 1, 1879.

WILBER.

IN THE UNITED STATES PATENT OFFICE.

IN THE MATTER OF INTERFERENCE
THOMAS A. EDISON, INTER-
FERENCE, M. CASE 141.

ss.

EMILE BERLINER; Speaking
Telegraph.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

(Interference M.)

(Filed Sep't. 28, 1878.)

CITY, COUNTY AND STATE OF }
New York, ss.

THOMAS A. EDISON, being duly sworn, deposes and says, that about April, 1873, I discovered that plumbago placed in the electric circuit and subjected to varying

pressure, produced a rise and fall of tension. About April 1876, I applied this discovery, in connection with a diaphragm, in a speaking telephone.

I continued to experiment with varying success until February 9, 1877, at which time the machine was fully and successfully operated. I thereafter proceeded to develop more fully the other points of the apparatus, and to bring it before the public. Between September 1876, and January 1877, I tried the phonautograph in connection with the tuning fork, to cause a rise and fall of tension, but I have been unable to find any memorandum by which to define the note accurately. The speaking telephone, with carbon point and diaphragm, was publicly introduced in July or August 1877.

THOMAS A. EDISON.

Sworn and subscribed before me this
25th, day of September, 1878.

GEORGE S. PIERCEY,
Notary Public,
Kings County.

Approved May 1, 1879.

WILDER.

CASE 1.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that he conceived the point in controversy some time before March 1877, reduced it to practice March 25, 1877, and actually tested the instrument between Menlo Park and the Western Union Telegraph Office in New York City, which resulted in transmitting and reproducing fairly the human voice; several persons witnessed the exhibition. That he has a drawing of the

instrument made and dated March 5, 1877. That he feels sure that he used this device earlier than the above date, but so far has been unable to find any sketches of it.

That he thinks the point in controversy is shown in his patent No. 233,014 of April 30, 1878. That he has a sketch dated April 1, 1877, showing the point in interference in a different shape.

That he has other sketches made in April and May; one May 25, 1877, especially contains the exact designs and devices shown in deponents application. NO. 141.

Since these dates and up to the present time he has been engaged in experimenting and making telephones, and is now engaged on experiments on telephones in which devices of this character are employed.

THOMAS A. EDISON.

BEFORE HON. COMMISSIONER OF PATENTS.

IN THE MATTER

of

Interference Edison-Dobson-
Gray-Bell-McDonough-Rich-
mond-Volkers-Irwin-Blake.
Imp't in Telephones.

Chas. A. to N., and
No. 1. 2

NEW YORK, November 1, 1880.

J. J. STROUROW, Esq.,

Atty. for Bell and Blake,

Sir:—In the above entitled matters of interference
please to take notice that on Monday, November 8, 1880,
at 10:30 o'clock, A. M., at the laboratory of T. A. Edi-
son, Esq., at Menlo Park, New Jersey, I shall proceed to
take the testimony of the following witnesses in behalf
of said Edison, E. T. Johnson, John Kreutz, Chas.
Batchelor and T. A. Edison, of Menlo Park, N. J., and
J. T. Murray, of Newark, New Jersey, and perhaps others.
The examination will be continued from day to day until
completed. You are hereby invited to be present and
cross-examine.

LEMUEL W. SERRELL,
Atty. for T. A. Edison. 3

4 Service of a copy of the foregoing acknowledged this 2d day of November, 1880.

JAMES J. STORROW,
For Bell & Blake.

FRANK L. POPE,
Atty. for DeLear.

Service of a copy of the foregoing acknowledged this 1st day of November, 1880.

BALDWIN, HOPKINS & PEYTON,
Attys. for Gray.

5 Service of a copy of the foregoing acknowledged this 2d day of November, 1880.

GEO. W. DYER,

Atty. for Irwin and Volkers.
Atty. of record for Richmond.

Service of a copy of foregoing acknowledged this eighth day of November, 1880.

JAMES W. McDONOUGH.

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THOMAS A. EDISON.

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IN THE UNITED STATES PATENT OFFICE.

BEFORE HON. COMMISSIONER OF PATENTS.

IN THE MATTER

of

The interferences on 'Telephones'
between Thomas A. Edison,
A. E. DeLear, Elsie Gray,
A. G. Bell, J. W. McDonough,
G. B. Richmond, W. L. Volkers,
J. H. Irwin, and Francis
Blake, Jr.

Cases A to N

and

No. 1.

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Deposition of witnesses examined on behalf of Thos. A. Edison, pursuant to annexed notices, at the laboratory of T. A. Edison, Menlo Park, New Jersey, on Monday, Nov. 8th, 1880.

Present—L. W. Serrell, Esq., on behalf of T. A. Edison; W. D. Baldwin, Esq., on behalf of E. Gray; Col. Geo. W. Dyer, and Mr. Betts, of Messrs. Betts, Attorney & Betts, on behalf of Messrs. Irwin, Volkers, and Richmond; and J. J. Storow, Esq., on behalf of Messrs. Bell and Blake.

THOMAS A. EDISON being duly sworn, deposes and says, in answer to interrogatories propounded by L. W. Serrell, Esq., as follows:

Q. 1. Please state your name, age, residence and occupation?

A. My name is Thomas A. Edison; 33 years of age; residence, Menlo Park, N. J.; occupation, inventor.

Q. 2. Please state the general circumstances under

which you were led to experiment upon acoustic and telephone instruments, and the dates when you so commenced?

A. The first knowledge I ever had of an acoustic instrument operated by electricity, was an article published in some paper which I cannot recollect, but which I think I saw about 1872. This instrument was Reiss Transmitter and Receiver, exhibited by Prof. Vanderwyde, before some society in New York.

The instrument was described and illustrated in the publication to which I refer.

The next time my attention was called to sound vibrations in connection with electricity, was, I think, in the summer of 1874.

This apparatus was invented by Elisah Gray of Chicago, and I had it described to me about that time.

The object of the invention was to transmit several independent messages by breaking up musical waves of different rates of vibration into short and long sounds, constituting the Morse alphabet.

When I heard of this, I began to read upon the subject of acoustics, as I was interested in not having my Quadruplex replaced by another method. Soon after I had heard about Mr. Gray and had his instrument generally described, I obtained a copy of a book entitled "The Wonders of Electricity," translated from the French of J. Bailly, and published by Scribner, Armstrong & Co., at New York, in 1872. I think I obtained this book, either in the fall of 1874 or the winter of 1875.

What I mean by the winter of 1875 is, January, February or March, 1875.

(Counsel for Edison gives notice that the said book will be used at the hearing of these cases, and references made especially to pages 140, 141, 143, 143.)

The same, also, being reprinted in PRESCOTT'S SPEAKING TELEPHONE, published in 1878, on pages 47, 48 and 49.

*Reiss
same 72*

Gray.

*Bailly
Electricity*

*in
Prescott
pages 47 &c*

What particularly struck my attention in this book was the statement, made on page 142, in which it states about two plates being used, one at one end of the line and the other at the other end of the line—one setting the other in vibration; and the author speaks of the possibility, when the instrument shall have been perfected of transmitting conversation in this means.

I exercised my mind considerably upon reading this to imagine what was meant by these two plates, and what means were used, or could be used, to transmit conversation.

I came to the conclusion that some means or methods must be used whereby loud sounds and low sounds could be transmitted, and I resorted to my mind methods whereby this could be carried out. The conclusion I came to was that it was essential to increase or decrease the resistance of the circuit; but I did nothing at that time towards carrying out any experiments at all.

But I had, in 1875, devised means and methods whereby waves of electricity of varying strength could be transmitted over telegraphic circuits and reproduced there by means of a magnet. This is shown in my Patent, No. 141,777, of Aug. 12, 1875.

(A copy of the patent referred to offered in evidence to be known as "EDISON'S PATENT No. 141,777.")

It was the means shown in this patent for varying the resistance of a circuit in proportion to the amplitude of vibration that I thought of in connection with the transmission of weak and loud sounds or modulations.

In June or July, 1875, I think in July, Mr. Orton, the President of the Western Union Telegraph Co., sent for me to call and see him. I did so within a day or two after he sent for me. He stated to me that Elisah Gray, of Chicago, was creating quite a stir with his acoustic inventions, and he desired me to take hold of the whole subject of acoustics as applied to telegraphy,

*141,777
patent*

*June 75
got Reiss*

and see if there was anything in it that would be useful to the Western Union Telegraph Co., and he asked me if I would take the matter up and enter into a contract with that company to investigate the whole subject. I stated that I would do so if the contract was satisfactory. He made some verbal agreement with me until we could settle on a proper contract, while I was to go at experimenting at once.

This contract was finally satisfactorily drawn up, and it was signed on the 14th of December.

(Counsel for Mr. Edison here produces the contract for the examination of the respective counsel, and also content a copy of the same is to be made by the notary and put in evidence in place of the original, the same being designated EDISON'S CONTRACT, W. U. TEL. CO., DEC. 14, 1875.)

Within a few days after I had first seen Mr. Orton on this subject as above stated, and in July, 1875, I received from him a translation in English of the original article on the Reiss Telephone, which he sent for my information.

(Counsel for Edison here produces the said translation for the inspection of the respective counsel, portions of the same being published on pages 9 to 12 inclusive of PRESCOTT'S WORK ON SPEAKING TELEPHONE.)

After receiving the translation I read it over very carefully, but found that it contained nothing more than what I had previously read regarding the Vanderwyde-Reiss instrument.

In relation to that portion of the translation which referred to articulate speech, I sketched upon one of the

sheets of the translation some few devices which I proposed to try. These sketches were made within certainly ten days from the time of receiving the translation, which was about July, 1875.

(Counsel for Mr. Edison produces photo-lithograph copies from a tracing of one of the sketches referred to, the original being here present, but being in pencil, and the paper somewhat dirty, the same is not as distinct as when the copy from which the photo-lithograph was taken was made, and the original and photo-lithograph are submitted for comparison. The said photo-lithograph being marked translation by W. U. TRANSLATOR OF REISS' TELEPHONE.)

It is contended by the respective counsel that all the exhibits in the form of written memoranda, or drawings that may be put in evidence, shall be considered as formerly introduced and offered in evidence, and said exhibits shall be photo-lithographed, and the copies received in evidence with the same force as the originals, that said originals shall be in the possession of Mr. Edison, or his counsel, to be produced at the hearings or at any of the proceedings, upon suitable notice. That whatever model exhibits or instruments are put in evidence shall also be considered as properly offered in evidence, with or without special notice to that effect, and that correct drawings shall be made of such instruments, and photo-lithographed, and the same shall be received as evidence, the same as the actual articles, and said articles shall be in the custody of counsel for Edison, to be produced at the hearing, and upon reasonable notice, whenever called for, and that copies shall be furnished to the respective counsel as soon as possible, each party of course having the right to enter any objection on the record.

*Lorentz's
sketches
on
Pie-
trans. -*

22 THOMAS A. EDISON.

Q. 3. Please describe what is represented by the pencil sketches upon the said exhibit 1.

A. These devices, are for varying the resistance of a circuit, containing a constant current, by the energy of the voice.

The same being retranslated into sound waves by the action of the electric waves upon a magnet.

The top figure consists of a tuning fork, a resonant case, a wire from the diaphragm on such resonant case, connected to one prong of the tuning fork. The other fork having upon its extremity a metallic point, which was immersed in a cell containing mercury, covered with alcohol. This cup is marked "mercury like Helmholtz."

The drawing underneath, at my left hand, consisted of a chamber with a diaphragm; to this diaphragm was connected a lever pivoted at a point upon the base of the instrument, the extremity of the lever not connected to the diaphragm, is provided with a point which was immersed to a great extent in a cell containing water, and immediately over another point of metal also in the water. These two points separated by water, formed the two poles of the circuit. The idea was, that upon speaking into the chamber, the lever connected to the diaphragm would be vibrated, and approach and recede from the fixed electrode in the cell, according to whether the voice was loud or low, and thus diminish the length of the column of water between the two electrodes, or increase the length of the same, thereby varying the resistance proportionate to the amplitude of the diaphragm. Included in this circuit was an electro-magnet, whose poles faced one side of the prong of a tuning fork. This was the receiver, and was placed in a chamber. It was to be used to reproduce the electrical vibrations set up by the vibrations of the electrode connected to the diaphragm. A battery was included in the circuit of these two instruments.

Below these two figures on my left, is another device for varying the resistance of the circuit. This consists of a diaphragm fixed to a chamber, having in its center

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THOMAS A. EDISON.

a knife-edge facing another knife-edge, connected to the base of the instrument. These knife edges, or at least one connected to the base, was to be adjusted to and from the other knife-edge, immediately over those knife edges, was a funnel filled with water, with drip wick, which allowed water to drop upon the knife edges, run, along them, and be held by capillary attraction. The knife edges were a short distance apart.

The vibration of the diaphragm, carrying one knife edge caused it to approach and recede from the other knife edge, and thus throw in and out of circuit more or less of that portion of the circuit which consisted of water, and thus vary the resistance of the same.

The object of the drip wick was to supply the loss due to electrolysis into oxygen and hydrogen. I have spoken as if these instruments were made. I do not mean to say they were made.

My sketches were rough ideas of how to carry out that which was necessary in my mind, to turn the Tesla transmitter into an articulating transmitter. They were notes for future use in experimentation.

Q. 4. Did you converse with any one, as far as you remember them, in relation to the proposed speaking instrument, and if so, with whom and about when?

A. I think I conversed with a great many people on the subject, but I cannot recall with certainty any one except Mr. Batchelor, my assistant James Adams, one of my assistants who is now dead, but there were many people around the laboratory when I was experimenting on mental and vocal transmission, among whom I may mention Chas. F. Edison, now dead, Jno. C. Reiff, of New York, E. H. Johnson, of New York, R. T. Gilliland, now living at Indianapolis, Indiana, John Kruesi, Robert Spivey, and many other persons. It was a kind of a public place. My laboratory at that time was at 30 and 12 Ward street, Newark.

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*Corrected
about it*

(Counsel for Gray objects to the above answer as involving matters not set forth in the witnesses preliminary statement).

(Counsel for Edison replies that the preliminary statement in interference A, refers to the matter in controversy, and gives the date as July, 1875).

Q. 5. What, if anything, was there in your mind of improvement that you sought to decide, as distinguished from the Reiss telephone?

A. I sought to devise a transmitter, or rather an addition to the Reiss telephone, which allowed one to talk low, or to talk strongly, and have the same reproduced low, or strongly. I felt certain that when this was accomplished speech could be transmitted and reproduced.

Q. 6. State whether or not, in your judgment, at that time the Reiss telephone was adapted to that object, and if not, why not?

A. It certainly was not, or I would not have made these diagrams. I could not conceive how strong and weak sounds could be transmitted by intermitting a current of constant electro motor force, without the aid of some device or some alteration that would vary the strength of the current.

Q. 7. State whether or not your subsequent experiments confirmed your original opinion that you had on this subject?

A. Yes; if no attention is made in Reiss' apparatus.

Q. 8. When did you move from Newark?

A. I cannot recollect the exact time, but, as near as I can recall it, it was in March, 1876.

Q. 9. State whether or not it has been your custom to make sketches or drawings and to date the same, and have them witnessed, and, if so, about when you commenced that practice?

A. It has; I commenced, in a small way, some time

*Imp on
Reiss*

*Reiss
was
adapted to
talking*

*move from
Newark
March
1876.*

in 1873, to have my sketches witnessed, but very few sketches were made compared to those made in 1877, when I commenced the practice of placing note books all over my laboratory, with orders to my assistants to draw out and sign every experiment; previous to 1877 drawings were made on all sorts of scraps of paper and thrown in a drawer.

Q. 10. State what has been your habit in regard to the fixing of dates upon drawings?

A. It has been to make the drawing, immediately sign it and date it, explain it to my assistants, and have them witness it, and this is most always done on the same day that the drawing is made; in case the date was not put on the drawing, and it was afterwards found, no date was allowed to be put upon it.

Q. 11. Have you preserved all of your sketches and drawings; if not, what has become of some of them?

A. I think I have preserved them all since about March 1877; but most of the drawings made in 1875, with some recent books of workmen's accounts, went astray when we moved from Newark to Menlo Park, and have not since been found; in 1876, the keeping of these records was done in a very loose manner, and continued till 1877, when I adopted, as I have stated, the plan of putting note books all over the laboratory, each of which was numbered.

Q. 12. Of the sketches that were made in the year 1875, have any been preserved, and, if yes, are there any that bear upon these interferences, and, if so, please produce the same, and describe the devices that these sketches are intended to represent?

A. Yes, sir; I have sketches which bear upon these interferences; the sketch I now offer in evidence, marked Ex. 7-2, was made November 16, 1875; it is signed by myself, witnessed by Charles Batteledor, James Adams and John Kresel. It shows a magnet spool connected to binding posts, through the centre of this spool passed a long spiral iron wire stretched between two posts in such a manner that when the coil or magnet spool was

Ex 7-2

energized by electricity the iron coil became magnetized and demagnetized as the circuit was opened and closed, causing each turn of the spiral to come in contact or leave its adjacent convolution. This spiral of iron was connected in a circuit, and these motions produced by the magnetization and demagnetizations of the spiral caused an increase or decrease in the strength of the current passing through the same, that is through the spiral by reason of the contact and separation of the convolutions of the spiral, one short circuiting the other.

The magnet spoon, although not shown on this diagram as being connected to anything but binding posts, was connected in circuit with a series of tuning forks, which tuning forks threw in and out of the line resistance when they were vibrating. These waves acting upon the magnet coils shown in this diagram set the iron spiral in vibration and caused a change in the resistance of a local circuit containing a magnet, such diminution or increase in the strength of the current being proportionate to the strength of the vibration. The local circuit was never opened, but the electrical waves representing sound waves were thrown into it by the varying resistance caused by the movement of the spiral iron wire.

The instrument, as illustrated in this diagram, was made and used. I should say it was made within a day or two after Nov. 16, 1875.

The next sketch which I produce is marked EXHIBIT 9-9.

This sketch shows a resonant box with a tuning fork mounted upon it; to one prong of the tuning fork is connected a spiral spring of German silver wire, the other extremity of the spring is connected to an adjusting screw passing through a pillar fastened to the resonant box, the object of the screw being to adjust the tension upon the spiral spring.

The tuning fork, spiral spring, the screw and the post are included in a local closed circuit, containing a battery and a magnet.

Upon the vibration of the tuning fork, the German-silver spring was set in vibration and resistance thrown in and out of the circuit in the same manner as described in my EXHIBIT 7-9, and the sound waves which act the tuning fork, in vibration, were translated into this closed circuit.

The following is written upon the sketch by myself. The sketch is dated Nov. 16, 1875, and was made at that time. It is signed by myself, witnessed by James Adams, Charles Batchelor and John Krussel. The writing upon the sketch was made at the same time that the sketch was made. It is this:

"X, German-silver in circuit, with quantity battery, and 12 ohm sonometer, when fork is not vibrating each turn of the spring, touches its neighbor, and the sonometer X is closed and Y is opened, when fork vibrates, it sets the spiral in motion and separates each coil, put in a large resistance, this opens X and closes Y."

This instrument was made and the open mouth of the resonant box, was placed in front of another resonant box, upon which was mounted a tuning fork, actuated by an electro magnet, which magnet was in a circuit containing a fork, which was also actuated by a magnet, and was provided with means for either opening or closing the electric circuit, to make a musical sound, or increasing and decreasing the resistance of the same, to produce the same result. The fork in EXHIBIT 9-9 was set in vibration sympathetically, by the motion produced by the other fork upon the resonant box adjacent to it.

(Answer objected to by counsel for Gray, as involving matter not specified in the Preliminary Statement.)

(Counsel for Edison replies that these progressive efforts of Mr. Edison were so extended that it was impossible to introduce everything in the Preliminary Statement, and that he has shown nothing but what the Preliminary Statement warrants.)

7-9

40 THOMAS A. EDISON.

Q 13. Did you ever apply the device you have just described in a speaking telephone?

A. Yes, sir, I have; it is shown and described in my patent 393,013 granted April 30, 1878, filed Dec. 15, 1877, fig. 6. (The same being offered in evidence.)

Q 14. Have you any other sketch illustrating any similar device to EXHIBITS 7-9 and 9-9, if so please produce the same?

A. I here produce a sketch (offered in evidence, marked EXHIBIT 6-9) in which the spiral spring of EXHIBIT 7-9 and 9-9 is replaced by a battery called a polarizing battery. I will now describe how the instrument worked as illustrated in this sketch:

A tuning fork was mounted upon a resonant box and was set in vibration sympathetically from another fork through the medium of air waves. Placed on this resonant box was a battery which contained a liquid which caused a powerful polarization of the electrodes. This was included in a closed circuit containing a magnet, when in a state of rest the battery was so powerfully polarized that scarcely any current passed through the circuit, but the slightest noise would cause partial depolarization of the electrodes, and the strength of the current would be increased, thus translating the vibrations of the fork into a closed circuit through the medium of a variable resistance.

This sketch was made, as well as the writing upon it, Nov. 14, 1875.

It is signed by myself, witnessed by James Adams and John Kruess.

The following is written on it:

"X is a quickly polarizing battery, which depolarizes powerfully with the least jar, as the tuning fork responds only to vibrations in union with its swinging time, it will be set in motion, and this, in its turn, will set the resonant box vibrating, depolarizing or knocking loose

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the hydrogen bubbles on the plates of the battery X increasing the strength and closing the sounder, the S should have very low resistance."

I will state that the S in this case means the sounder. In EXHIBIT 10-9 (here offered in evidence) the lower sketch is what I refer to in the exhibit. In this, as in the previous exhibit, a resonant case is used with a tuning fork mounted upon it, and is worked in the same manner as in previous exhibit; but upon the resonant box are four levers pivoted at the extremity of the resonant case and having contact points upon their other extremities, these points being in contact with points upon the resonant case. The circuit, which is a closed one and containing a battery and a magnet, passes through all these levers and their contact points. If now the fork be vibrated, a jarring motion is given to the levers, and a series of bad contacts, or irregular or indefinite contacts, are made at all four points, throwing the constant current in the line into undulations, as in the previous exhibit.

This exhibit was made Nov. 18, 1875, signed by myself, witnessed by Chas. Batchelor and James Adams.

I made such an apparatus and worked it, and it worked as I intended. The apparatus was probably made within a day or two after the drawing was made and signed.

It was certainly made within four days after the date upon the exhibit.

The next EXHIBIT 22-9 (here offered in evidence), was made Dec. 20, 1875, is signed by myself, is witnessed by John Kruess and Robert Spivey.

This instrument consisted of a tube within which another tube was placed, sliding in and out after the manner of a telescopic tube; in front of the stationary tube was a wide plate of tin, in front of which was an electro-magnet, which electro-magnet was energized by electrical pulsations, representing sound waves. The end of the tube which slid in the stationary tube was provided with a rubber tube, the end of which was capable of being placed in the ear. When the electro-magnet was ener-

gined by several series of electrical waves representing sound waves, and it was desired to pick out any one of such series and render it more audible than the others, the sliding tube was adjusted in, or outward to a point where the column of air in the chamber was in proper tone with the series of vibrations which it was desired to render more audible. These several series of vibrations were simultaneously given out by the tin plate. When I say tin plate, I mean an iron plate coated with tin.

This instrument was capable of rendering audible any sounds whatever, transmitted telegraphically.

This instrument, and I think two others, were made within 24 hours after the sketch was made and dated.

There is written upon this exhibit the following:

47 "Read: 'Please start on this right away with Jim; if you want less, there is an order you can fill on my desk.' This is not in my handwriting, but I believe it to be in that of Mr. Batchelor.

What is meant by "less," is this: a lens plate had a piece of iron soldered to it, or riveted to it, to act as an armature to the electro magnet, but I remember a tin plate was used instead.

The upper figure, marked "6 inches" upon it, was used to slide in the stationary tube upon which the diaphragm was secured. It shows one end closed with a small tube protruding from it, to which was secured the rubber tube to convey the sound to the ear.

48 Adjourned to 10 1-2 o'clock, Tuesday, Nov. 9th, 1880.

S. L. G., Notary.

all sounds

LABORATORY OF T. A. EDISON,
Menlo Park, New Jersey,
Tuesday, Nov. 9, 1880.

Met pursuant to adjournment.

Same parties present.

Continuation of examination of T. A. EDISON:
Q. 15. Have you any instruments corresponding to the device illustrated upon the Exhibit 22-0?

A. No, sir; the instruments made were taken apart and used for other experiments.

Q. 16. Had you made, before December 20, 1875, any acoustic instrument having a magnet, a resonant case, and a diaphragm?

A. Yes, sir; I believe I made three instruments.

The instruments were made, perhaps, the middle of November, 1875.

They consisted of tubes, iron diaphragm, and electromagnets in front of the diaphragm, the same precisely as the telephone receivers, now universally used, except the magnetic constant was produced by a battery instead of a steel magnet.

Q. 17. Can you produce such instruments, or either of them?

A. I can produce two of the first ones made; I do produce them.

(Same offered in evidence, and marked
"Edison's INSTRUMENT A AND A',
Nov., 1875.")

Q. 18. State whether or not those instruments, EXHIBITS A AND A', were actually used, and, if so, in what manner?

A. The instruments were used as soon as made in my office, at 10 and 12 Ward street, Newark, in November, 1875. Three instruments were placed in the same cir-

cuit, in which circuit was a constant battery and three reeds, having different vibrating periods, caused fluctuations in the resistance of the circuit, setting up sounds of various kinds, to which the three instruments acted as receivers. These instruments were so constructed that the diaphragm of one was larger than the other; in other words, each instrument had a different sized diaphragm. The idea being that the small diaphragm would reinforce the high, and the large diaphragm the low notes. These sound waves were broken up into definite intervals by a Morse key, so as to form dots and dashes, for the purpose of transmitting three different messages over the wire simultaneously by sound waves, rendered audible by these receivers. Perhaps as many as fifty people saw these instruments working in November, 1875, in the manner I have described.

They were also taken over to the Western Union Telegraph office within a week after testing them in my laboratory, and were put in operation there and exhibited to Mr. Orton and John Van Horn.

Reeds were used, which in their vibrations transmitted the waves by cutting in and out battery by means of a contact point; also by cutting in and out resistance by an electrolytic cell.

In no case was the circuit interrupted or entirely broken when these receivers were used at that time.

(Conced for Edison offers in evidence a certified copy of the CAVEAT, No. 75, signed and sworn to by Mr. Edison on the 13th of January, 1876, and filed in the Patent Office January 14, 1876, the same being introduced as being partially illustrative of the circuit connections spoken about in the last answer, and also as representing certain instruments that have been spoken about by the witness, and to be used as evidence in this case and all matters that it contains.)

On
APR 11
Publicly
seen.

Case # 95

Q. 10. Please state what the device represented on fig. 14 of the said Caveat shows?

A. It shows a telescopic resonant chamber, with a rubber tube ear piece, with a strip of iron in front of the chamber, act in vibration by the electric waves, representing sound waves in the suggest in front of it. This apparatus is similar to that shown in my EXHIBIT 22-9.

Q. 20. What difference, if any, is there between the INSTRUMENTS EXHIBITS A AND A' and the device shown in EXHIBITS 22-9 and fig. 14 of the Caveat?

A. In EXHIBIT 22-9 a strip of iron was fastened across the end of the tube, whereas in EXHIBITS A AND A' iron diaphragms were used.

Q. 21. Have either of the EXHIBITS A AND A' been changed since they were originally made?

A. No, sir; I don't think they have, except that I notice one of the diaphragms has become partially unadhered.

Q. 22. State whether or not EXHIBITS A AND A', when properly adjusted, can now be used as telephone receiving instruments?

A. Yes, sir; they can be used and were a long while for that purpose, and I have already stated that there is no difference between these receivers and the receivers universally used, except in the method of producing a constant magnetic field in them.

Q. 23. About how often and during what periods have Exhibits A and A' been made use of for receiving acoustic vibrations transmitted electrically?

A. They have been used from the time they were made in Nov. 1875 at various intervals up to the spring of 1877, especially EXHIBIT A', and another instrument with a larger diaphragm, and which was one of the three first made.

Q. 24. So far as the action of the instruments A AND A' is concerned in receiving and rendering audible acoustic vibrations translated into electrical waves or vibrations, does it make any difference whether the original

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air vibrations proceed from musical tones or from articulate speech?

A. Those instruments are capable of translating from electrical waves any sound whatever.

Q. 25. At the time those instruments, EXHIBITS A AND A', were made, which was shortly before the contract was signed by the Western Union Co., did the terms of that contract and of your employment by that Company, specially direct your attention to the transmission of telegraph messages, or to the transmission of articulate speech?

20 (Question objected to by counsel for Gray as calling for the construction of a written contract and for the inference drawn by an interested party as to the meaning of a verbal contract the terms of which are not stated.)

(Counsel for Mr. Edison replies that he does not call for his interpretation of the contract, but what the attention of the witness was directed to.)

A. To both.

Q. 26. And so far as a transmitting device is concerned that was adapted to the transmission of articulate speech, previous to the construction of the instruments EXHIBITS A AND A', had you made any device specially adapted thereto, or sketches of any device specially adapted thereto?

A. I had made sketches of an instrument for that purpose, which is shown in EXHIBIT REISS TELEPHONE translation.

I had also made an instrument, I think in Oct. or Nov., 1875, for measuring the resistance at different intervals between metallic electrodes in electrolytic solutions.

This instrument was not adapted to the transmission of articulate speech, but was an instrument to ascertain

Reiss

transmission

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the availability of exceedingly slight motions of immersed electrodes to increase and decrease the resistance of a circuit.

I tried a great number of different chemical solutions with this instrument.

I also used vibrating plates provided with an immersed electrode, the vibration of such plate varying the resistance in the line.

Some forms of these instruments were capable of being used for the transmission of articulate speech, but they were not used for that purpose.

Q. 27. Please state in that connection about when it was that you did actually use instruments for the transmission of articulate speech?

A. The first instrument made for the transmission of articulate speech was made some time in Dec., 1875.

Q. 28. Please tell us what that was and what you did with it?

A. It consisted of a stretched membrane with a point of wire fastened to its center and immersed in electrolytic fluid, the wire electrode being adjusted so as to be immediately opposite another electrode, the two separated by a short column of water.

Q. 29. Having reference to your PATENT 141,777 and the REISS TELEPHONE TRANSLATION and the sketches that you made thereon, what, if anything, was necessary for you to do in actually constructing a complete and operative telephone.

A. Nothing, except to adapt to the lever 1, fig. 1, in my patent, a means for concentrating the energy of sound waves, upon it, so that it could be set in motion proportionately to the amplitudes of such sound waves, to the end that the resistance of the electrolytic cell should be increased or diminished in proportion to such variable amplitudes of vibration and throw upon the line which in this case is closed and never broken, a series of undulatory currents, having the same quality as to pitch and amplitude as the original sonorous waves which gave motion to the lever 1.

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Articulate speech
Dec. 75

Water telephone

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Reiss sketch

Moss could then be attached to the lever of the magnet *n*, for simplifying and rendering more audible these vibrations.

What I mean by "means" is a device such as a resonant box, whose sides or top might be connected to the lever of the magnet *n*, or a diaphragm connected to the lever of the magnet *n*.

Q. 30. Having the EXHIBITS A AND A', in November, 1875, which you have stated were and are adapted to use as a telephone receiver of articulate speech, and the electrolytic cell, and electrodes, as shown in fig. 1 of your patent, 141,777, do you understand correctly by your answer to the 29th question that you simply added the stretched membrane to the said electrolytic cell, to produce a complete speaking telephone?

A. I added the stretched membrane to the electrolytic cell, shown in fig. 1 of my patent, 141,777, dispensing with all other devices shown in fig. 1, except the electrolytic cell.

The circuit connection between the stretched membrane transducer, with electrolytic cell and the receiver A1, was the same as in my said patent.

Q. 31. What was the result of the use of these transmitting and receiving instruments, which you have spoken of as made and used in November and December, 1875?

A. The results were entirely unsatisfactory.

Q. 32. To what, if anything, can be attributed those unsatisfactory results?

A. In the first place, I am quite deaf myself, and one of my assistants had to listen.

In the second place, such assistants did not have any faith in the possibility of accomplishing the result desired.

In the third place, we used too much battery. It produced considerable decomposition in the electrolytic cell, and made corrosive sounds in the receiving instrument.

In the fourth place, it was difficult to keep the points adjusted.

(See C)

Unsatisfactory results, Nov. & Dec., 1875

In the fifth place, the experiments were conducted in a very noisy place.

In the sixth place, the resistance of the magnets used on the receivers were wrong for this kind of transmission.

In the seventh place, the receiving diaphragm was too thick for rendering audible over and above the noise any sound waves due to speaking into the transmitter.

Q. 33. Were the experiments that you have spoken of as made in Dec. 1875, the only effort that you made in the year 1875, to carry out your original conception of the possibility of transmitting articulate speech electrically?

A. It was the only direct trial actually with the voice, but other devices were made and tried, which were adapted to the transmission of articulate speech, and which were afterwards as applied.

Q. 34. Please state which those devices were?

A. They are the devices shown in EXHIBIT T-9, 9-0, 10-0, and 6-9, and also in another sketch, which I now present.

(Counsel for Edison exhibits this sketch and the accompanying description, dated Nov. 17, 1875, to the respective counsel, the same being in a book known as Experimental Researches, Vol. 1, p. 23, and as the said book contains other matters not relative to this case, he asks that it be consented that the Notary make a copy of the text and a tracing of the drawing, to be received with the same force as the original, and the same to be marked EXHIBIT DEPOLARIZATION OF BATTERY, NOV. 17, 1875.)

(The foregoing request is acceded to by the respective counsel.)

Q. 35. Please describe the bearing that the instrument

See m
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shown in this sketch has upon the questions now in controversy?

A. This sketch shows a battery with one of its electrodes attached to a vibrating reed, D, which was kept in constant vibration by a local circuit and self make a break contact points on the reed D, and spring E, contact being made between them.

This vibration of one of the electrodes of the battery in and out of the field produced a rise and fall of tension, in a closed circuit containing a magnet, C, both by the effect of a disturbance of the polarization of the electrode, and also by a greater or lesser contact with the Mobile electrode or liquid.

Q. 36. Referring to EXHIBIT 10-9, state what action, if any, was produced thereon by atmospheric sound waves?

A. In the experiment made with the apparatus shown in sketch or EXHIBIT 10-9, the ultimate effect of the sound waves was, their translation into the closed circuit containing the magnet and battery, by reason of a diminution or increase or variation in the intensity of contact between the four contact points of the levers upon the Mobile cover of the resonant case.

Q. 37. Which, if either of the sounds in this interference, did the said apparatus shown on EXHIBIT 10-9 correspond with?

A. It corresponds to the count in Case 1, except that a lever or levers were used in place of a spring, and the initial pressure between the points upon the mobile cover of the box and the levers was obtained by the action of gravity.

Q. 38. State whether or not the levers employed on the instrument, EXHIBIT 10-9, were rigid, and whether or not the resonant box operated in the same manner as a diaphragm?

A. They were pivoted, and were not rigid. A resonant box acts in the same manner as a diaphragm.

Q. 39. What, if anything, would be the difference in the

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action of the instrument shown in EXHIBIT 10-9 and the instrument shown in Mr. Voelker's application and in Mr. Irwin's application now in interference, so far as the transmission of electric waves corresponding to the sound vibrations?

A. If Mr. Irwin and Mr. Voelker used metallic contact points, and their instruments worked, then the instrument shown in EXHIBIT 10-9 would also work in the same manner, as far as an alteration in the intensity of contact is concerned.

Q. 40. I now read to you the counts in Interference A and B, and ask you which, if either of the instruments made in 1875 contains the subject matter of said counts?

A. The instrument shown in EXHIBIT 9-10, 10-9, the instrument shown in my patent 141,777, the instrument shown in my EXHIBIT DEPOLARIZATION OF BATTERIES correspond with the counts in INTERFERENCES A AND B.

Q. 41. Which, if either, of the instruments used in 1875 corresponds to the counts in INTERFERENCE E?

A. The instrument EXHIBIT A AND A', and the instrument shown in EXHIBIT 22-9.

Q. 42. Did you at any time, if so, when, file a caveat, showing a device corresponding to the count in Interference E?

A. Yes, sir; I filed a CAVEAT, NO. 74, January 14, 1876, in addition to the one mentioned after my 18th answer, which exactly corresponds to the count in INTERFERENCE E. Figure 4 shows that instrument.

(CAVEAT NO. 74, sworn to January 13, 1876, filed January 14, 1876, offered in evidence.)

Q. 43. Please describe the operation of said receiving instruments shown in the said caveat, and state which, if any, were actually made?

A. There was a line, or closed circuit, in which several

*Interference
A. B.*

*Inter
E. -*

*Case 1 74
Jan 14 76
Shows
Inter E.*

series, or a series of electrical vibrations corresponding to sound waves, were passing; in this circuit (fig. 4) was an induction coil, which consisted of a closed iron magnet or ring upon this closed ring was a helix or bobbin of wire induced in the circuit.

There was also another bobbin of wire upon the closed ring, which bobbin was included in a circuit containing an electro magnet, between the poles of which was a polarized steel plate. The broad side of this plate was immediately in front of a telescope chamber provided with an eyetube. The waves circulating in the line circuits were thrown by induction into the circuit containing the receiver, and the plate was set in vibration by positive and negative current, and the sound desired was rendered audible.

This instrument was made in November or December, 1875.

The receiving instruments shown in Figs. 11 and 12 are different in their ultimate working from that shown in Fig. 4, as the sound waves, instead of being conveyed to the ear, were made to agitate a contact point, connected to a spring having a disk in front of the resonant chamber.

The spring and contact point were connected in a closed circuit having a battery and magnet.

The instruments shown in Figs. 11 and 12 were made some time in November or December, 1875.

They were tested and used.

Q. 44. Please state whether or not you ever employed with a vibrating instrument, such as a reed or a diaphragm, a spring contact point, pressing upon such reed or its equivalent, and yielding more or less to the motion thereof, an electrocircuit passing through the spring and contact point?

A. Yes, sir. Such an apparatus is shown in the second drawing of EXHIBIT 22-9, and also on the EXHIBIT 8-9.

Also, on page 39 of the volume here present of "Experimental Researches."

(By consent the same is offered in evidence, and the jury is authorized to empanel a copy for the original, the same to be marked "ACOUSTIC TELEGRAPH, NOV. 30, 1875.")

Q. 45. Please describe the operation of these instruments EXHIBITS 8-9 and the SECOND 22-9 and any others you may have bearing upon the point enquired about?

A. The object of these contact springs in EXHIBIT SECOND 22-9 is to produce contacts without interfering with the free vibration of the moving body. It consists of a vibrating reed upon each side of which at the extremity are two electrodes consisting of springs with contact points, each springs capable of being adjusted to or from the vibrating body, and also a screw for increasing or diminishing the stiffness of each spring.

This instrument was made within a few days after the date which is marked upon it, Nov. 21, 1875. Several of these instruments were made and tested.

In EXHIBIT 8-9 is a tuning fork, which in its vibration moved a contact spring to and from a contact point.

The spring and contact point being the two electrodes of one circuit, and the fork and contact point being the two electrodes of another circuit.

In EXHIBIT ACOUSTIC TELEGRAPH, NOV. 30, 1875, is shown a tuning fork set in vibration by an electro magnet provided with a yielding contact spring, forming with the fork the two electrodes of a circuit containing the battery and magnet, and in the circuit of which was also another electro magnet fastened to a resonant case, and which served in connection with this resonant case to reproduce audibly and to set in motion sympathetically from the waves of the vibrating fork in the circuit another fork mounted upon the resonant case, with the electro magnet, the latter fork in one case touching in its vibration a rigid point, which served to control a local circuit containing a battery and a magnet, but

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which right point was afterwards dispensed with for the reasons set forth in the written portion of that exhibit, which is that the right screw or point dampened the fork badly, and a yielding contact point was afterwards substituted for the right point, so as not to interfere with the free vibration of the vibrating body.

In the writing contained on that exhibit it is stated that we did not succeed in getting these to work satisfactorily, but this was due to a want of correspondence in vibrating periods of the two forks, and not to the devices just described.

In EXHIBIT 10-9, in the top figure on the left hand side is shown a tuning fork free to vibrate and making contact by a mobile contact point formed of a globe of mercury. The contact point being so arranged that upon the outward vibration of the fork the globe of mercury would spread out and the other contact point would be immersed in it.

The object of using this mobile contact point was to allow a perfect freedom of vibration in the vibrating body, so that none of the devices necessary to be used in connection therewith should of themselves so interfere with the true vibrations of the vibrating body as to alter the character of the vibrations, and at the same time control a circuit.

Q. 46. Can you produce any instrument corresponding to fig. 4, in your CAVEAT NO. 73, filed Jan. 14, 1870?

A. I here produce an instrument which is a portion of the instrument shown in fig. 4.

Instrument offered in evidence and marked
EDISON'S EXHIBIT B, NOV., 1875.

Q. 47. Please describe how this instrument operated?

A. The instrument was operated by positive and negative current, acting in the electro-magnet, which set the

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plate vibrating in front of the chamber where the sound of the same was heard.

The vibrating plate was polarized by a permanent steel horse shoe magnet.

It was used in connection with an induction coil, the primary of which had a series of waves corresponding to sound waves thrown in upon the circuit by a variation of resistance or electro-motive force having round and direction, which waves were altered into currents of varying direction, in an inducing circuit, containing this instrument.

The instrument was made and worked, I think, in November, 1875, I am positive that it was made within one month of the 14th of November, 1875, before or after.

It is easy to be seen that the proper working of the faults of this instrument are such that it could not have worked satisfactorily and it did not do so.

Had it been made in a proper manner, it would have worked more satisfactorily.

The difficulty was, it was not sufficiently hard, besides, we had difficulty in getting a correspondence between the different plates used upon the receiving instrument, and the corresponding plates upon the transmitters, but this was not the fault of the instrument as an invention, but in the making of an instrument, vibrating plates having different rates of vibration were used for transmitting.

Q. 47. Please look at your application No. 145, now in interference, filed December 13, 1877, and state whether or not the same corresponds to this instrument, EXHIBIT B?

A. It does correspond, except no induction coil is shown in this EXHIBIT B, but I did use an induction coil with EXHIBIT B, as before stated.

Q. 48. Please state what the device is shown in figures 12, 15, 16 and 17, on your CAVEAT NO. 73, filed January 14, 1870, and state whether or not either of these devices was actually made or used.

A. They were used as receivers for rendering audible sound waves transmitted through the medium of electric waves.

would have worked

The apparatus shown in fig. 19, was made, but the chamber marked "resonator" was a tube in the place of being partially spherical. Over the mouth of this tube was stretched a membrane, in the center of the membrane there was secured an armature of soft iron, cylindrical in shape and passing partially down through a hole in a coil of insulated wire, marked receiver.

The case was made of sheet iron bent round in the form of a cylinder.

An ear piece was provided for listening.

This apparatus was made some time in November, 1875.

89 It was used as a receiver for rendering audible sound waves transmitted through the medium of electric waves, which it did satisfactorily.

Fig. 15 consisted of a vibrating plate passing in front of the mouth of two resonant chambers, provided with listening tubes, such plate being set in vibration by an electro-magnet.

Fig. 16 represents an iron chamber surrounded with wire.

The theory being that the expansion and contraction of the iron of the chamber by magnetization would set the air therein in vibration and render sounds audible.

This apparatus was made some time in 1875—I think about March. I have the original, which I will try and produce.

90 It did not work with the means of transmitting at our command. Whether it ever will work will depend upon the amplification of the electric waves. The apparatus shown in fig. 17 was made in November or December, 1875, and consisted of an iron chamber tubular and surrounded with wire.

This also failed to work satisfactory.

Some of these devices are represented in my patent, No. 198,087, December 11, 1877.

Q. 40. Please refer to the photo-lithograph which I now hand you and state if you know what it is?

A. It is a photo-lithograph of the original drawings

furnished L. W. Sarrett, and from which Figs. 15 and 16 of CAVEAT 75 were made.

The fig. that has been scratched over represents a telephonic receiver. It consists of a case, an ear piece, a membrane, an armature on such membrane, and an electro-magnet driving such armature. Why it was not put in this caveat, and why it was scratched out I cannot say at this late date.

(Photo-lithograph offered in evidence, and original to be produced, the same being marked, "SKETCHES FOR CAVEAT NO. 75.")

Q. 50. State whether or not you had had any apparatus corresponding with this figure that is marked across previous to the time of furnishing such sketch to Mr. Sarrett?

A. I am not absolutely sure that I had a stretched membrane with a flat armature secured to it as shown in the sketch, but I think I did.

But I made the form shown in Fig. 19, CAVEAT 75.

Q. 51. Please state what difference, if any, there was between the device shown on the sketches for CAVEAT NO. 75, that is scratched across, and the device referred to in answers to interrogatories 27 and 28?

92 A. One was a transmitter and the vibrations of the diaphragm parted the resistance of the circuit. It had no magnet, whereas the instrument illustrated in the scratched diagram consisted of a membrane with an iron armature, an electro-magnet to give motion thereto, the instrument being capable and adapted to receiving and rendering audible sound waves of any kind or character transmitted telegraphically, as also in Fig. 15, CAVEAT 75, and EXHIBIT A AND A'.

Q. 52. Will you please describe any telephone instrument you made in 1878?

A. In February or March, 1876, I took up the subject of transmitting articulate speech, using transmitters

which varied a volume of water, and continued these experiments for some time, constructing instruments in various forms and varying the resistance by various means in which water was employed or other chemical solutions.

I here produce a sketch (EXHIBIT 3-10) with two figures and some writing thereon, the handwriting being that of my assistant, James Adams, now dead. It is dated either Jan. 6, or July 6, 1876.

I think it must have been made in July.

The instrument consisted of a tube with a diaphragm, and a pillar and contact point. Between the diaphragm and the contact point was placed a piece of felt saturated with water and salt water and other chemical liquids. This was used for transmitting articulate speech. A receiver was used with a diaphragm and a magnet in front of it.

The writing states that a great many words were received plainly; such as "How do you do."

The whole of the statements on that paper I cannot make out entirely.

On the back of this exhibit is marked the following: "July 6, 1876," "this experiment," and another word which I can't make out.

I have here a sketch marked EXHIBIT 26-10, which consists of two chambers provided with membranous diaphragms, to the centre of which was secured a reel on both of them, which reels were act in motion by electro magnets.

These two tubes were connected together by an ear piece. The sketch is dated May 8, 1876, and signed by myself. I think the experiment was tried about that time, instruments being used that had been previously made. I think as far back as November or December, 1875.

Upon the said exhibit the following is written in my hand writing:

"One reel, one note higher than other, first part of

"not sent on one reel, and other part on other reel
"then giving up and down stroke distinctive, causing the
"operator to read without trouble."

"The operator read dots and dashes made up of sound vibrations, listening at the ear-piece marked 'ear'."

I here produce a sketch marked EXHIBIT 20-15, which was made by my assistant, James Adams. It has a date, "5th, 1876," but the month has been torn off. It was probably made within a day or two of the EXHIBIT 3-10.

The following is written upon the sketch:

"Platina point and brass diaphragm; trial paper wet
"with different chemicals; could get it, but articulation
"not very good."

I have here a sketch, marked EXHIBIT 58-10, dated July 29, 1876, signed by myself and witnessed by James Adams and Charles Labadie.

This instrument consists of a number of contact springs with contact points resting upon the surface of a diaphragm resting upon a chamber.

The following is written thereon in my own writing:
"I think the high notes are made by the middle of the
"diaphragm only vibrating, while as the notes are lower
"more of the diaphragm vibrates, hence by placing con-
"tact points from center to rim may get different rates
"and have levers cut in and out resistance."

I have stated that these contact points were springs. I make a correction. They were levers.

I cannot remember whether the instrument was made or not. The intention was to transmit articulated speech. The words "speak here" are written at the bottom of the chamber carrying the diaphragm.

I here present a sketch made by myself, dated July 29, 1876, No. 71-10.

The sketch shows a transmitter and a receiver for the transmitter. A better glass was to be used, provided with a small tube extending out from its bottom, the

glass filled up to a short distance below the top of the small tube with water. In the water were immersed two electrodes of a closed circuit containing a magnet and a battery, the magnet being in front of a diaphragm connected to a chamber. The idea was to speak into the heater that the body of water in the heater would move and amplify the water in the small tube.

The following words are written upon the sketch:

"X water, idea being to speak in heater and set the water vibrating, thus giving large amplitude in small side tube and thus increase and decrease the resistance, giving the proper waves to magnet so as to carry on a conversation."

101 On the lower part of the exhibit is written as follows:

"Instead of employing a lens mirror on the neck of a Thompson mirror galvanometer, I propose to employ a thick mirror about 1-2 inch long and 1-32 inch wide, or even smaller."

This instrument was made perhaps within a day or two after the date of the sketch, but did not work.

About May, 1876, I started Mr. Gilliland to experiment upon this subject, and with him was some one else, I think Mr. Adams, these experiments were continued along to about August, and later, in fact they were never discontinued.

102 I have here a paper in Mr. Gilliland's handwriting, dated August 2, 1876, which is put in as EXHIBITS 101-10, 102-10, 103-10, 104-10.

I produce an EXHIBIT MARKED "TALKING TELEGRAPH, JULY 12, 1876."

This sketch illustrates a transmitter consisting of a tube with a diaphragm to the center of which is fastened a number of strings. These radiate out some distance from the face of the diaphragm and are connected to contact springs in front of contact points.

The springs and points are all included in a closed circuit containing a battery and a telephone receiver; upon speaking into this tube the contact points were

vibrated, and resistance was thrown in and out of the closed circuit at one or more points by the vibration of the springs produced by the voice acting upon the diaphragm and springs.

This instrument was tried; the results were not satisfactory.

I here produce another sketch marked EXHIBIT 79-15.

This sketch represents a telephone transmitter consisting of a lever fastened to the center of a diaphragm, and having upon its extremity a peculiar pear or diamond shaped contact plate, the lower extremity of which is immersed in an electrolytic fluid, such as water.

The vibration of this electrode inwardly and outwardly from the water, but not breaking contact with the water, allowed of a greater or less surface of contact, to be made between the electrode, and the water.

The other electrode was immersed in the water, the whole formed part of a circuit, in which there was a battery, and a telephone receiver. It did not operate satisfactorily.

I produce EXHIBIT 73-16, dated JULY 27, 1876, which shows three chambers with diaphragms upon their ends, with rigid contact points, facing the center of each diaphragm, and connected with resistance coils, in such a manner in an electric circuit that the circuit is never broken. The contact of one or more diaphragms, with the contact points serving to cut in and out resistance from the circuit.

In this circuit was a battery and a telephone receiver. This instrument was made about July 27, or 28, 1876.

This was used for transmitting articulate speech, but it did not work.

There was a common chamber at the open ends of the three tubes, into which the person spoke.

What I mean by saying that it did not work was that it did not transmit articulate speech satisfactorily. That you could tell that some one was talking, and if you

knew what they were saying it sounded awful like what they were saying.

I will now refer to EXHIBIT 104-10. This consists of a resonant tube, or a chamber provided with a diaphragm immediately opposite to a spring, secured at one end by a screw, and near the center to the diaphragm, and upon the end of the spring is a T, having notches, against which a number of contact springs fixed or rested.

These springs were arranged with resistances, so that by the vibration of the springs connected to the diaphragm a complicated system of contacts were made, which put in and took from a circuit resistance, the circuit containing a battery and a telephonic receiver.

This instrument was constructed, perhaps, about Sept. 1876, although it might have been a month later than that.

That sketch was made in August, 1876. The instrument did not work satisfactorily.

Another form is shown in EXHIBITS 102-10, which consists in a multiplicity of contacts, in connection with a vibrating spring, set in motion by a diaphragm.

This instrument was also made and worked to a sufficient degree to allow us to hope.

This principle was experimented on up to the middle of 1877, and is embodied in my patent 208,012, dated April 30, 1878, filed Dec. 13, 1877.

In sketch 105-10 is shown an illustration of a tube, with a diaphragm resting upon a flexible pipe joining two reservoirs of water. In each reservoir was an electrode, and the same were included in a circuit containing a battery and a telephonic receiver.

The resistance of the circuit was altered by a compression of the flexible tube altering the size of the column of water between the reservoirs.

This instrument was made and it was said to work very good.

I think it was made either in August, or September, 1876. It is embodied in my patent No. 208,018, dated

*water
resistance*

*Aug. or
Sep. 1876*

April 30, 1878, filed December 13, 1877, figure 5 and figure 7.

I here produce a sketch marked EXHIBIT 106-10, which consists of a number of strips of metal stretched between two frames, with contact points in the centre of them, in front of which are spring contacts.

The strips were stretched to respond to different rates of vibration, and the contact points and springs were so arranged with resistances all included in a closed circuit containing a telephonic receiver, that when the voice actuated the spring a multiplicity of contacts were made cutting in and out resistances from the circuits.

This sketch is dated August 10, 1876.

I do not remember of the instrument ever having been made.

Adjourned to Wednesday, Nov. 10th, 1889, at 10 1-2 o'clock A. M.

S. L. G.,
Notary.

LAWYERS OF T. A. EDISON,
MEXICO PARK, N. J., Wednesday, Nov. 10, 1889.
Met pursuant to adjournment.

Some parties present.

Continuation of examination of Mr. T. A. Edison.

Q. 53. Have you all of your drawings that were made in 1876, and if not, where did any of them go to?

A. No, sir; I have not. As I have previously stated in my testimony, we were very careless about keeping drawings, which continued up to 1877. Most of the experiments regarding the production of the speaking telephone in 1875 and 1876 were made by my assistant, Mr. Adams, who used any person who happened to be about to do talking upon instruments which he had constructed.

He kept a record of these experiments in a book belonging to himself.

*Adams had
drawings with
him when
he died.*

When he was sent to England to conduct some experiments on the British Post Office Telegraph with telephones, he took the book with him.

After dying, and the return of his widow to America, I sent for all papers relating to experiments made by Adams which she might have.

I received only a few detached papers, which was all she had, and did not receive the book.

The reason why I did not try these experiments myself was on account of the fact of my deafness.

Q. 54. The interference, case No. 1, involves the subject matter of a spring forming or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes, and yield to the pressure of the diaphragm?

In your preliminary statement in this case you say you have a drawing of the instrument made and dated March 5, 1877, that you feel sure you used this device earlier than the above date, but so far have been unable to find any sketches of it?

Please state what devices you made use of which eventuated in the production of the specific devices set forth in the subject matter of case 1, and how these devices operated, and produce any drawing bearing upon this subject?

A. If you mean a flexible spring electrode with contact point in contact with another flexible body, such as a reel forming the other electrode, then the devices were made and used in November, 1875.

EXHIBIT SECOND 25-8, Nov. 21, 1875, EXHIBIT 8-9, Nov. 16, 1875, and in CAVEAT No. 71, dated Nov. 22, 1875, filed Dec. 2, 1875, all the figures.

A certified copy of the CAVEAT put in evidence.

The instrument shown in this Caveat consists of a transmitter and receiver for the transmission of sound waves broken up into dots and dashes.

The transmitter consists of a sounder upon a resonant case, having upon the end of its lever a vibrating reel, provided with a contact point at its end, and facing a spring contact electrode, which in its turn is in contact with a limiting contact screw.

The vibration of the reel connected to the sounder lever is obtained by the concussion of the sounder lever upon its lower anvil.

The reel is set in vibration by this jar, and comes in contact with the spring electrode at each vibration, separating the spring electrode from the contact point and throwing a battery into a closed circuit.

These vibrations passing over the line, energise an electro-magnet arranged so as to set in vibration a resonant case, and the vibration of this resonant case sets in motion a vibrating reel upon the opposite side of which at its extremity the spring contact points, flexible, and vibrating with the vibration of the reel, the reel and flexible spring electrode are in circuit with the battery, and a magnet, thus the vibration of the resonant case shown in fig. 3, are taken up by the reel 15, and such vibrations are thrown into the local circuit by the reel and contact points.

I have stated in this caveat that the instrument shown in fig. 2 may be used as a transmitter to repeat the wires transmitted from the apparatus shown in fig. 1, into another circuit.

I have also stated therein that although the spring pendulums are primarily set in motion from a jar or vibration received from an electro-magnet, I have mentioned that other source of power may be used in this connection.

I will mention that the object of spring contact electrodes in contradistinction of rigid point electrodes when used in connection with vibrating bodies is to allow of the free vibration of such bodies while performing their duties of controlling the electric circuit, and that the object is identical, whether the vibrating body be a tuning-fork, a reel, an untuned strip, or a diaphragm.

Case
No. 1

Only State
Sub. 5. 77
device

Case from

Lower devices
No. 71.

I produce a drawing marked EXHIBIT 152-15; it has no date upon it. It was made by James Adams.

It has the following written upon it:

"If that fellow don't go away I am going to put lights out and put induction coil on him."

I remember that this drawing was in existence on the night when the election returns were being received at my laboratory, in the presidential election for Hayes and Tilden which was Nov. 1876.

That night a drunken man came into the laboratory and Adams wrote what has been read and passed the paper to me for my approval.

The diagram shown on that sketch consists of two telephones, one of which had a yielding spring electrode capable of being adjusted to or from the diaphragm.

This has reference to the subject matter of case 1.

I cannot say whether this instrument was put in operation. My impression is that it was, as Adams was trying all kinds of experiments with telephones during the whole of 1876.

Q. 55. Please refer to your ENGLISH PATENT NO. 2909, July 30, 1877, here offered in evidence, and state whether or not either of the devices therein represented corresponds with the subject matter in case 1.

A. Yes, sir; the device shown in figure 10, next to the case in that case, also those in Figure 11, Figure 16, Figure 9, Figure 25, Figures 19 and 24.

These devices were all made and used previous to the filing of the complete specifications in this case Jan. 30, 1878, and many of them before July 1877.

Q. 56. State whether or not you were pursuing experiments with spring electrodes in the circuit of a telephone acting to press one electrode against the other and maintain the required initial pressure between the electrodes, in connection with a diaphragm or similar vibrating body and during what time these proceedings were carried on?

A. In nearly every experiment with telephones for the transmission of articulated speech made since Dec.

1875, up to the fall of 1877, means or devices were generally used to allow of the free motion or vibration of the transmitting diaphragm.

When other vibrating bodies were used not set in motion by the waves of the voice, yielding electrodes were also used for the same purpose.

Q. 57. In connection with the experiments that resulted in the production of the carbon transmitting telephone, what evidence have you to present?

A. In a speaking telephone I was seeking to devise means and methods to translate the complicated sonorous vibrations of the human voice with all its modulations into electric waves, representing exactly the sonorous sound waves, and the generic principle was that such devices should be actuated by the human voice, and that the movements of such devices, produced by the energy of the human voice, should control an electric circuit containing a source of electro-motor force, such as a battery, to the end that the power or energy alive in such circuit should be controlled by the sonorous waves of the voice perfectly, so that having these waves of electricity circulating in a closed circuit, they could act upon an electro-magnet, which, in its turn, would set a body capable of being vibrated in motion, so as to produce

sonorous waves, and thus reproduce from such closed circuit articulated speech; and I do not think that a week has passed since December, 1875, until the present time, that some thought has not been given, or that experiments have not been tried to attain the object as I have set it forth. As I was early convinced that if the transmission of articulated speech was ever done commercially, it would be by this means. A fact which is now fixed, as nearly all transmitters of articulated speech are based on this principle, and were devised by me.

I refer more particularly in this latter statement to the carrying out of this system by means of interpolation in a closed circuit of carbon or analogous substance, con-

Object sought

*Exhibit 1.
Eng. Pat.
July 30 77*

pressed, agitated, set in motion, or jarred in any manner by mechanism set in motion by the human voice; since 1875 many lines of experiments were carried out, all having the same object and working upon the same principle as just set forth.

Variations in a column of water produced by the movements of a diaphragm, cutting in and out resistance, in the form of wires by a diaphragm, cutting in and out resistance by the movement of a multiplicity of spring contact points, cutting in and out resistance by the movement of the diaphragm by short circuiting to a greater or less extent thin films of streaks of conducting material on hard bodies, altering the resistance by agitating a diaphragm with points in an electrode formed by loose carbon.

Also by the compression of finely divided conducting material when used in the point of an electrode.

All these plans have been worked out so far as the state of the art will permit.

Many times, either with one or the other aggregations of devices would be laid aside to be taken up again, and all the experiments repeated under different conditions and with increased knowledge derived from thought and experimentation in other lines.

The plan of varying the resistance by altering the column of water, although started in 1875, was not completely worked out to make it a commercial success in the absence of any other method, until a short time previous to my application, case No. 144, filed September 5, 1877, and my patent, 205,018, dated April 30, 1878, filed Dec. 13, 1877.

The methods shown in my Exhibits 102-10 and 101-10 were experimented with in an enormous number of ways, and were carried out as fully as the art will permit in my patent 205,018, dated April 30, 1878, application filed Dec. 13, 1877.

The experiments of cutting in and out resistance by wire coils was finally carried out in the same patent above.

The principle of cutting in and out films of a conducting substance was carried out in my application No. 120, filed April 27th, 1877. The principle of compression of finely divided conductors is also contained in that application No. 120, as well as the patent No. 205,014, April 20, 1878, filed July 20, 1877.

The origin of the method wherein a column of water was varied, was, as I have already stated, due to the reading of the article in the work of J. Balbi, in connection with the experimental knowledge which I had, arising from my *Patent* 141,777, August 12, 1873, and set forth my "Exhibit REISS TRANSLATION."

The method of cutting in and out resistance in spiral wires to translate sound waves was carried out in 1875, and shown in my EXHIBITS 7-9 AND 9-9.

Experiments whereby the sound waves were translated by agitation of a number of contact points altering the resistance of the point of contact, is shown in my EXHIBIT 1048.

The principle of varying the resistance by cutting in and out of circuit by means of a diaphragm, more or less of a film of plumbago on a hard surface were conducted at various intervals from, as near as I can remember, March, 1876, until 1877.

The only Exhibits which I have been able to find in which this device was used in its early stages, I here present.

(Photolithograph of a sketch offered in evidence, marked EXHIBIT, OCT. 12, 1876, for identification.

This Exhibit consists of a diagram and some writing, both made by my assistant, James Adams. It is dated Oct. 12, 1876. Signed by myself and James Adams.

The apparatus consists of a tube with parchment diaphragm, having fastened to its center a stick of Arkansas oil-stone, coated with plumbago and dipping in a cup of water. The water forming with a plate immersed

*Letter C,
Water.*

*Sketch no
105-10.*

therein one electrode, while the conducting surface of plumbago formed the other electrode.

The film being to cut in and out of circuit more or less of the plumbago film.

The following is written upon this exhibit:

"This works, but not so good as plumbago on hard rubber, tried mercury instead of water, but it is a 'dead make and break.'"

What is meant by plumbago on hard rubber, was the sheet circuiting of a film of plumbago on hard rubber, by a spring connected to a diaphragm, and resting on the film, which served in its motion to cut in and out resistance due to the film of plumbago.

Such a method is shown in EXHIBIT 117-15, in which a piece of either hard rubber or stone, coated with carbon, is used with a circuit passing through it, a piece of felt resting on the diaphragm and provided with a mutilated face, being in contact with the surface of carbon. The vibration of the diaphragm, cutting in and out, or rather sheet circuiting a portion of the film.

This Exhibit is not dated, it is signed by James Adams. It might have been made as early as April, 1876, or as late as March, 1877.

I have here three Exhibits, one marked 83-15, one marked 80-15, and one marked 81-15. These are drawn by myself, and all are witnessed by James Adams.

When these diagrams were made, it is impossible for me to state with certainty.

They were either made in March or April, 1876, as illustrations of experiments to be carried out, or else they were made in perhaps Nov. or Dec., 1876, for recording experiments that had been made.

The experiments were made with the devices herein shown in these three Exhibits, between March, 1876, and January or February, 1877.

The sketches shown in these Exhibits mostly refer to cutting in and out of resistance in a closed circuit, by a

movement derived from a diaphragm, the resistance being a film of carbon on stone.

The diaphragm moved spring contact points and increased or lessened the total length of conducting film in the circuit.

The resistance varying according to the length of this carbon film that is included in the circuit.

In the EXHIBIT 83-15 the top figure on the left hand side of the sheet illustrates a device slightly different from the carbon film; the following words are written underneath the sketch:

"In the centre of the resistance of the
"solenoid no current passes to line;
"but if the platinum spring is vibrated by
"the diaphragm either one side or the
"other, currents pass to the line whose
"strengths are in proportion to the
"strength of the tone"—i, e., it realizes
"the mathematical requirement for
"transmitting the voice, like two diaphragms and a string."

In EXHIBIT 81-15 bottom figure illustrates a device which will be clearly understood by the following, written underneath:

"Thick lead or plumbago on diaphragm
"membrane, the agitation of the membrane separates (more or less, according to high or low note) the contact particles, and with intensity
"battery of low quantity, vary strength
"at each tone."

These experiments were started, as near as I can remember, in March, 1876, were continued for a short time, laid aside, taken up again and again laid aside several times.

Our confidence being kept up by getting sentences now and then that were said to be pretty good.

In all these experiments I had to rely upon my assistant on account of my deafness.

I here present an exhibit having a sketch and some writing upon it. This sketch is marked 2-11. It is dated January 29, 1877. It was made by Mr. Adams.

The sketch is not clear as to the devices employed; but I remember the experiment, which was the first attempt to apply the property of carbon of varying its resistance by pressure, which I discovered in 1873.

It consisted of a diaphragm and three platinum points immersed in a dish containing loose carbon.

The talking, although every year in quality, was of a sufficient volume that it could be heard through the teeth when an ordinary Morse relay, the magnet of which was included in a circuit, was held against the teeth.

I here present an instrument (marked "CARBON RHÉOSTAT") made in 1873, in which carbon was used in an electric circuit, and the resistance of the same varied by pressure.

This instrument was used in experiments on artificial cabbles where a great resistance was to be subdivided into a greater number of lesser resistances, for the purpose of allowing condensers to be attached between each resistance, to give the proper electro-static capacity to the same, and thus imitate, as far as possible, the condition for transmission through submarine cables.

Ten different instruments of this character were started in my shop, but only the one here presented was finished, as it was found that the resistance of carbon varied with every note, jar or sound, and were too unreliable where a definite resistance was required.

It was also found that expansion and contraction altered the resistance.

That the pressure of the electrodes in contact with the carbon varied the resistance; hence the other nine instruments were not made, and coils of wire were substituted for these resistances and another plan was adopted.

*Carbon
1873*

During January, February and March, 1877, we were very busy in taking advantage of this property, which I had recalled to my mind by some incidents which I now forget. My application No. 130 works partially upon this principle and partially upon the cutting in and out principle. It will be seen in that application that I set forth two ways of accomplishing the object sought, one of which is cut in and out of a surface of plungers, and also by a greater or less influence of contact.

I here present a sketch marked exhibit "ORDER for CASE No. 130," which I have obtained from L. V. Serrell, made in his office at time he was preparing case 130. It was made for his information, to illustrate that which was essential to transmit articulate speech.

In this sketch is shown a Reiss transmitter with a spring electro-magnet in front of a point upon the diaphragm, and the device substantially as shown in my application No. 130.

Two lines of dots are thereon shown, made to represent electrical waves corresponding to sound waves.

The upper row of dots representing waves of invariable intensity, as sent from a Reiss transmitter and the lower line representing waves of variable intensity as sent by my instrument.

case 130

The following is written upon the sheet:

"Speaking consists of sound at one rate of vibration."

Also:

"Electrical contact of variable resistance, or intensity of contact."

The sketch is dated, probably by Mr. Serrell, March 28, 1877.

The direct application of this principle in a patent application is shown in patent No. 238,124, April 30, 1878, filed July 20, 1877, wherein spring electrodes provided

with carbon points were in contact with a diaphragm of the transmitter and the pressure between the diaphragm or one electrode and the flexible spring and carbon point forming the other electrode were varied by means of a screw.

I here present an EXHIBIT 8-11 made Feb. 9, 1877, signed by myself and witnessed by Chas. Batchelor and James Adams, and is the original sketch from which the instrument shown in my application 120 was made.

I think the instrument was made within one or two days after making the sketch, that is, Feb. 10, or 11.

I here present another sketch marked 15-11, in which wet paper was substituted for a platinized surface to ascertain the effect.

I here present a sketch marked Exhibit 20-11, dated March 25, 1877, signed by myself and Chas. Batchelor, which is the same as that shown in my patent No. 252, 014, which instrument was made, at least an instrument with two diaphragms and chambers, perhaps a week or perhaps a month before March 25, 1877.

This instrument was publicly exhibited a short time before March 25, 1877, in New York.

The following words are written upon the exhibit:

"Four words, perhaps be better. The two give very fair speaking between New York and Mend Park, over No. 8 south W. C. wire."

Commencing in Feb. or March, 1877, I paid more attention to the preservation of my records, and I here present a great number relating to articulating telephonic transmitting based upon the principle of a closed circuit and a battery.

These exhibits are marked 9-11, 10-11, 14-11, 28-11, 27-11, 26-11, 25-11, 22-11, 21-11, 20-11, 19-11, 18-11, 17-11, 16-11, 20-11, 31-11, 32-11, 37-11, 30-11, 41-11, 40-11, 43-11, 44-11, 46-11, 48-11, 49-11, 512-11, 513-11, 56-11, 57-11, 60-11, 62-11, 65-11, 71-11, 70-11, 82-11, 87-11, 95-11, 99-11, 101-11, 102-11, 61-11, 113-11, 114-11, 115-11, 116-11, 120-11, 121-11, 122-11, 123-11, 132-11, 134-11, 135-11, 136-11,

137-11, 139-11, 140-11, 141-11, 142-11, 143-11, 144-11, 145-11, 146-11, 147-11, 148-11, 149-11, 150-11, 151-11, 152-11, 153-11, 154-11, 155-11, 156-11, 157-11, 158-11, 159-11, 161-11, 161-11, 162-11, 163-11, 164-11, 165-11, 166-11, 167-11, 168-11, 169-11, 172-11, 173-11, 175-11, 176-11, (two sides); 177-11, 178-11, 179-11, 180-11, 181-11, 182-11, 183-11, 184-11, 185-11, 186-11, 187-11, 189-11, 191-11, 192-11, 195-11, 196-11, 197-11, 198-11, 199-11, 200-11, 201-11, 111-11, 106-11, 86-11, 78-11, 58-11, 6-11, 49-13.

The exhibits that have heretofore been introduced in the interference cases of Edison, Blake and Wilson, cases 4, 5, 6, and 15, are here introduced, together with so much of the direct evidence of Mr. Edison in those cases as relates to those exhibits, by consent of respective counsel, which exhibits are as follows: 322-8, 320-8, 821-8, 30-11, 99-11, 184-11, 191-11, 196-11, 37-13, 105-12, 136-12, 164-12, 36-13, 1-13, 7-13, 8-13, 16-13, 64-15, 109-14; EDISON'S ILLUSTRATED DIAPHRAGM AND RUBBER TUBE DAMPENER; 64-13 ADDITIONAL; EXHIBIT EDISON'S SPRING FINGER, AUGUST, 1877; EDISON'S EXHIBIT MAGNETO PHOTOGRAPH TELEPHONE.

The instruments offered in evidence in same interference cases, 4, 5, 6, and 15, are also offered in evidence in this case.

The following exhibits are also offered in evidence, together with the testimony given in the interferences 2 and 3, between Edison, Blake and Chalmers, by consent, so much of the evidence in chief of Edison as has been taken in relation to those exhibits, is introduced into this case. They are marked:

42-11, 106-11, 112-11, 2-12, 6-12, 163-12, 188-12, 17-13; JOURNAL OF THE TELEGRAPH, APRIL 16, 1878; COVER OF LABORATORY NOTES; and the instruments that were made exhibits in said cases, are also here produced and made part of the record in this case.

THE PATENTS No. 232,015, April 20, 1878, filed

Aug. 28, 1877; and No. 208,209, September 24, 1878, filed July 30, 1877, are also introduced as exhibits in evidence in this case.

28 Q. During the year 1877, about what portions of your time was devoted to electrical appliances for transmitting speech?

A. Nearly all my time.

29 Q. And how many assistants did you have, if any, at work upon that subject?

A. Generally two engaged with myself in experiment with the apparatus made by workmen.

30 Q. Please describe some of the speaking telephones

you made, or had made, in 1877?

A. About in April, 1877, I made a telephone having a diaphragm; in front of this diaphragm were several springs similar to those shown in patent No. 203,914. On the extreme end of these springs were brass cups or shells; in these shells were cylinders of plumbago; the ends of the cylinders of plumbago were all adjusted so as to be in contact with each other, and with the diaphragm of the speaking instrument, the circuit passing up one spring to the extremity holding the plumbago passed through it to the next plumbago, and so on through the rest of the cylinders to the spring furthest from the diaphragm, thence to the other pole of the circuit; the lower end of these springs were secured to blocks of brass, provided with slots, and these were all secured to a block of insulating material by screws, which passed through the slots, which admitted of adjustment of the springs up or down and to or from the diaphragm or the adjacent springs. I have a drawing of this instrument; it was made and used, and worked well. This was done within one or two days, I think, of April 1, 1877.

31 Q. Who wrote upon this Exhibit "April 1, 1877," and when was it written?

A. It was written by me, I believe, at the time of making the drawing and on that date.

The figure at the top of the page over the date in EXHIBIT 42-11 illustrates this speaking instrument.

*Telephones
in 1877*

32 Q. Have you any of the parts of the instruments shown on this EXHIBIT 42-11?

A. Yes, sir; I have two of the springs, but without the plumbago cylinders.

(Counsel for Mr. Edison offers these in evidence, to be marked "EDISON'S EXHIBIT SPRINGS, 42-11.")

33 Q. Have you been able to find any other of the parts of the instrument shown on EXHIBIT 42-11?

A. No, sir.

34 Q. Please describe some more of the speaking telephones you made in 1877?

A. About May 26, 1877, I made a telephone with three springs, the tips of which had platinum points secured to them. One of the springs was weighted upon its extremity, to prevent the springs from vibrating excessively. These springs with their points were arranged substantially the same as shown in EXHIBIT 42-11, but in this case batteries were short circuited or shunted from the electric circuit at each vibration of the springs. Each spring had its own battery.

35 Q. Have you any drawing of that instrument, and, if so, please produce it.

A. Yes, sir.

(Counsel for Mr. Edison offers the said drawing in evidence, to be marked "EDISON'S EXHIBIT 106-11.")

In this instrument, illustrated by EXHIBIT 106-11, I did not employ plumbago or carbon, but I used platinum points.

36 Q. Did you ever make use of the instrument represented in the EXHIBIT 106-11; if so, when and to what extent, and with what results?

A. Yes, sir; about May 26, 1877, with very poor results. Commercially speaking, no results.

154 THOMAS A. EDISON.

67 Q. Please tell what difficulties you experienced?

A. Experienced difficulty in transmitting words which could not be recognized when the receiving operator knew what they were.

68 Q. Did you discover to what this difficulty was attributable?

A. Yes, sir; some of the difficulties we discovered. One of the difficulties was to keep the instrument adjusted always at the same degree. Another difficulty was that ordinary platinum points when pressed together do not modify the circuit to such a degree, or in such an even manner as to render waves produced by such compression of sufficient amplitude, or of sufficient evenness to be reproducible, with any degree of reliability, by my telephone instrument for sending such waves.

69 Q. When was the date put on EXHIBIT 106-11, and by whom, if you know?

A. I believe it to have been put on at the time that it was dated, by myself.

70 Q. Please describe some more speaking telephones made by you in 1877, or devised by you, and produce any sketch or drawing you may have of them?

A. I have a drawing here, dated May 21, 1877, drawn and dated by myself, at that time, and witnessed by Charles Batchelor and James Adams, my two assistants. The apparatus shown in this Exhibit (which is marked EDISON'S EXHIBIT 112-1), and offered in evidence is provided with a diaphragm. In front of the diaphragm are two springs, with plumbago between them. This instrument was made about May 21, 1877. The two springs pressed against the plumbago cylinder between them and preserved the continuity of the circuit, which passed from one spring, through the plumbago, to the other spring. The diaphragm pressing against these springs produced a rise and fall of the tension of the circuit. The large spring, which was a sort of a vibrating reel, was made adjustable, so as to press with more or less pressure upon the diaphragm.

It had some elasticity, and was very heavy, so heavy

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that it would not to any great extent follow the rapid motions of the diaphragm in vibrating. The difference in pressure was mostly produced by the inertia of this large bar or inequality to move with the same rapidity as the diaphragm subsequently, perhaps within two or three days after making the instrument the extreme end of the spring in front of the diaphragm was weighted so as to be incapable of responding to the vibrations of the diaphragm or any lower multiples of the same.

I have here some of the weights used upon the extremity of the spring or reel of this instrument, and also one of the caps holding plumbago, which was upon the end of the spring.

I had the spring itself within the last three months, but it has been mislaid. The spring was about five inches long from the clamping post, about three-eighths thick and five-eighths broad.

Counsel for Mr. Edison offers these weights in evidence to be marked "EDISON'S EXHIBIT WEIGHTS, 112-11," also the cap and carbon to be marked "EXHIBIT CUP AND CARBON, 112-11."

Q. 71. To what extent and with what result did you make use of the instrument shown in EXHIBIT 112-11?

A. The instrument worked very well. We worked with it for perhaps a week.

I also have here a drawing dated July 5, 1877, the drawings and date written by myself at the time, witnessed by Charles Batchelor and James Adams, the same being offered in evidence and marked EDISON'S EXHIBIT 2-12. I will now describe the middle figure on this Exhibit.

An upright cylinder had on its upper face a diaphragm secured to its end, the lower end was closed and had a mouth-piece, suitable for speaking in. In the center of the diaphragm there rested a disk of plumbago marked P, in the Ex. Four pins extended outward from the

plumbago, a short distance, to which strings were secured. The other ends of the strings were secured in the outer periphery of the diaphragm. The object of these strings was to hold it lightly on the diaphragm, and to prevent its moving away from the centre of the diaphragm sideways. The disk was also held upon the diaphragm by gravity. The diaphragm was connected to one pole of the circuit, while the disk of plumbago was connected to the other pole of the circuit. Variations in pressure between the surface of the plumbago and the diaphragm was made when the latter was vibrated. This variation took place, or depended almost entirely upon the inertia of the disk of plumbago. It is relative to the 2d point in case 2, as there was a vibrating diaphragm and a flexible weighted circuit governor. The circuit being varied or modified by inertia.

101 72 Q. Please tell us when this instrument was made, and whether it was used, and with what success?

A. I think it was made within a week or two of July 5, 1877. The instrument worked well. I also have here a sheet dated July 7, 1877, written at the date by myself, and witnessed by Chas. Batchelor and offered in evidence and marked EDISON'S EXHIBIT 6-13.

73 Q. Please describe the middle diagram in that sheet, and tell us whether the instrument represented thereby was ever made or used, and with what result?

102 A. The instrument shown in EXHIBIT 6-12 is almost like the one shown in 2-12, the difference being that a single thread is there shown, and the ends brought nearer to the center of the diaphragm, the action is practically the same. The instrument was made about the same time as that shown in EXHIBIT 2-12. Perhaps the same instrument was used to try this modification upon it, as we were in the habit of trying a great number of devices with the same chamber and diaphragm. One instrument being broken up or used, or parts used to try experiments on other forms of apparatus.

I have here, also, a drawing, written and dated by my-

self, Sept. 21, 1877, witnessed by Charles Batchelor, containing four diagrams.

(The same is offered in evidence marked EDISON'S EXHIBIT 165-12.)

Q. 74. Please describe the devices therein represented? A. I now mark the diagrams on this EXHIBIT No. 1, 2, 3 and 4.

No. 1 shows a diagram near the center of which there are four thin pins, between these pins is a disk of plumbago, having flanges cut upon it, through these flanges were holes, through which the four pins passed. A spring was secured near the outer periphery of the diaphragm, which served to press the plumbago against the diaphragm. In this diagram No. 1 is a note, which says: "working by momentum no adjusting screws;" this instrument, I do not think was made. In diagram No. 2, is a diaphragm, in the center of which is fixed a piece of metal; upon this metal there was held a piece of plumbago by means of a thread; upon the outer surface of the plumbago was a concave paper disk, the object of which was to resist the sudden movement of the plumbago when an outward movement of the diaphragm took place, thus modifying the degree of pressure between the plumbago and the diaphragm, both by the inertia of the plumbago and the resistance offered to the sudden conversion by the paper disk, the connection was made as in EXHIBIT 2-12, the diaphragm being connected to one pole of the circuit, and the plumbago to the other.

This apparatus worked well. The diagram No. 3 shows a slight modification. I herewith produce the diaphragm which I believe was used in the experiment No. 2.

(The same is offered in evidence marked EDISON'S DIAPHRAGM 165-13.)

The diagram No. 4 is similar to that shown in Exhibit 2-12, the difference being that the plumbago was held against the diaphragm by means of spiral springs.

Diaphragm

I am not sure that I made the modification shown in No. 4. I have here also a sheet, dated by myself Sept. 20, 1877, witnessed by Ches. Batchelor, containing several diagrams working upon the same principle, substantially, as that shown in EXHIBITS 3-12, and 6-12, and 165-125.

(The same is offered in evidence and marked EDISON'S EXHIBIT 188.12.)

Q. 75. Please describe the construction and operation of the respective devices therein represented?

A. I now number the parts Nos. 1, 2, 3, 4 and 5; they are all substantially the same thing, and the description of No. 1 will apply to all. No. 1 consisted of a cup made of vulcanized rubber, secured to the centre of the diaphragm; over this cup was another cup, which was larger and served to pass over the cup upon the diaphragm—in fact adjustable so that its outer end could be made to approach and recede from the diaphragm by a screw thread cut from the outer periphery of the diaphragm cup and the inner periphery of its cover. In the bottom of the cup was placed a disk of silk coated with plumbago; over this was placed a weight; on this, and reaching from the weight to the bottom of the cup, was a large spiral spring, which served to connect the weight with the electric circuit, the weight being one of the electrodes, and also served as a variable presser, the screwing in or out of the larger cup increasing or diminishing the initial pressure of the electrode upon the plumbago tuft. The diaphragm being connected to the other pole of the circuit, the variation in the strength of the current were brought about when the diaphragm was vibrated by a greater or lesser pressure due to the inertia of the weight forming one of the electrodes. This apparatus was made about the time at which the drawing was made, and worked well. The same apparatus is shown in my British patent of 1877, July 30, and numbered 2,909. By diagram marked Fig. 17, the specification of this patent relating to that subject and figure reads as follows, on page 9, lines 42 to 54, in-

elusive: "In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympan 10, Fig. 17, a small cylinder 7, of hard rubber or non-conducting material, within which is the fibrous tension regulator 4, resting upon a piece of platinum foil connected to one pole of the battery, and within this cylinder, 7, is a disc, 11, of iron or other metal, loose, but pressed towards the tension regulator by a spring, 8, and screw cap, 9, and the other electric conductor is connected with said spring. The inertia of the metal disc causes more or less compression of the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk, 11, to a yielding spring, 11, that extends across from one edge of the diaphragm to the other, as seen in Fig. 16. This construction of tension regulating device is equally available with large diaphragms." This specification was signed by me on the 21st day of December, 1877. The originals from which the specifications were prepared were furnished to Mr. Serrell some time before the signing aforesaid.

76 Q. Did you at any time construct a telephone instrument with a piece of graphite, or similar material, between two springs, in combination with a diaphragm other than those you have mentioned?

A. Yes, sir. I have here a sheet dated October 6, 1877, drawn and written by myself, and witnessed by Charles Batchelor, in which there are two springs with carbon between them. The apparatus consists of a diaphragm with a conical point secured to its centre, this point serving to separate the two springs, which were placed at right angles to the diaphragm, and thus relieve the pressure upon the carbon by the two electrodes which were connected in circuit. I herewith produce the diaphragm which I think was used in this experiment.

(Drawing offered in evidence marked "EDISON'S EXHIBIT 17-13," and the diaphragm offered in evidence marked "EDISON'S DIAPHRAGM 17-13.")

77 Q. Counsel for Mr. Edison offers in evidence a mica diaphragm marked EDISON'S EXHIBIT MICA DIAPHRAGM, and he is asked whether or not diaphragms of that kind, with the appliances thereon, have ever been made and sold—if so, when and to about what extent?

172 A. Yes, sir; they have been made. I think an order for several hundred was started in June, 1879, for a London Telephone Company. A large number were shipped there.

Q. 78. Was there more than one instrument made like that shown on EXHIBIT 188-12—state whether you remember?

A. Of that exact form and design, I don't think there was more than one made.

78 Q. Can you produce any portion of the original instrument shown in your Letters Patent 295,914?

A. No, sir; but I can produce a spring having upon its end a brass cup and a plumbago contact point, which was used in some experiments in 1877, about March, I think.

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(Said spring is offered in evidence, to be marked "EDISON'S EXHIBIT SPRING, MARCH, 1877.")

79 Q. Please examine the Exhibit drawings which you have put in, and state whether or not any changes or additions of any character have been made to said Exhibits since they were originally made, except the marks and numbers which have been made for the purposes of this examination?

A. No, sir; I do not think or believe any change

has been made other than those given in the question except numbers on the top left hand corner of some of the sheets, made by a person who took tracings of those drawings on tracing paper. There has been, in some cases, spots of ink on the paper which passed through the tracing cloth. I notice these spots on nearly all of the Exhibits. They are specially noticeable on EXHIBIT 42-11.

80 Q. Do those spots of ink in any manner change the drawings, or interfere with their being clear representations of what they were intended originally to show?

A. No, sir; I do not think they do.

81 Q. In whose possession have these Exhibits been since they were originally drawn, or under whose control have they been, and where have they been?

A. They have always been under my control, but they have been in charge of my bookkeeper, Wm. Carnan, and in the hands of Mr. Griffin, my secretary. They have also been in the hands of Mr. Serrell, of New York, for some time, they being taken there for the purpose of examination in connection with interference testimony.

82 Q. Some of these Exhibits have been injured on their upper edges. How did that arise?

A. They were torn out of books of the size of the cover which I now produce.

83 Q. Why were these torn out, and when?

A. They were torn out so that experiments relating to the same subject might have their records placed together. Every experiment having generally a title indicating what it was. It was done over a year ago, I think. My bookkeeper, Mr. Carnan, will be able to give the probable date.

84 Q. Do you remember whether there was anything being done at this time, when these drawings were being torn out, that rendered it important to select the records relating to particular subjects, and bring them together?

A. Yes, sir; I expected that they would be used in

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the interferences on the telephone. I also desired to make tracings, so that they could be kept apart for safety.

(The cover referred to introduced as a "COVER FOR THE EXHIBITS.")

85. Please now examine each of the Exhibit drawings referred to, and state whether or not the drawing upon each Exhibit was made at the date designated upon that Exhibit, and whether that drawing is still the same as it was at the date shown upon that Exhibit?

179 A. I believe that every drawing was made on the date written upon the paper, as I do not think any changes whatsoever have been made in the drawings. There has been in 1877 where drawings were made, and a date and title was not written there, but always within three or four days the date was placed upon the paper, which date was the date written, hence the diagrams would in this case be made before the date upon them. These books were scattered all over the laboratory, so that if I wished to express an idea, or explain a movement or design to an assistant, I would pick up a book nearest by, write the title, date it, put my name down, and make the drawings. When the book was full, they were collected together and fresh books scattered around the laboratory. We had been taught by numerous interferences the value of these records, and the necessity of figuring in books, in place of separate scraps of paper, which were very liable to be lost.

180 87 Q. Are all of the sketches and drawings which you have dated and witnessed, or have some of these precautions been overlooked or omitted?

A. I have many drawings taken from these books which are neither witnessed or dated, but the majority are both witnessed and dated.

87 Q. Have you found any more of the EXHIBIT SKETCHES 44-111?

A. Yes, sir, I have found one more.

*Correct
dates on
drawings!*

88 Q. Please describe some more inventions relating to speaking telephones, made or used by you in 1877?

A. Either in May or June, 1877, I conceived the idea of covering the edges of a diaphragm with rubber.

On June 26, 1877, I made a sketch in which was a diaphragm, whose edges on both sides were covered with rubber rings. I produce the sketch—it is the top figure in such sketch.

(Sketch offered in evidence, marked EDISON'S EXHIBIT 101-11.)

This Exhibit is dated June 26, 1877, signed by myself, and witnessed by Charles Buelcher and James Adams, my assistants. 182

The diagram was merely a sketch to convey to my assistants the idea as to how the experiment was to be tried, and is not a diagram of the instrument as constructed. This sketch shows a resonant tube with a screw upon the end of it; over this screw was screwed a ring of metal. Against this ring was placed a diaphragm covered with rings of soft rubber on both sides. In the actual instrument constructed, I believe the diaphragm was held against this ring by springs. July 20, 1877, another diagram was made, in which the diaphragm had rings of soft rubber on each side of it near its edges -- the explanations are upon the diagram itself. This Exhibit is witnessed by my two assistants, Charles Buelcher and J. Adams. I refer to EXHIBIT 37-12 -- the figures referred to are in the lower portion of the sheet. 183

Diagram offered in evidence, marked EDISON'S EXHIBIT 37-12.

The object of the rubber was to increase the sensitivity of the diaphragm by allowing it to have a greater amplitude, and also to get rid of the harmonic sounds of the metal, as well as to keep the diaphragm flat at all

times, by allowing it to expand and contract without hindering.

It accomplished these results for the reason that being clamped by a soft material the diaphragm when expanded by heat would cause the rubber to give and it would remain perfectly fit, whereas if it, the diaphragm, was clamped rigidly between metallic plates, it must necessarily have outward by expansion. Again, it was impossible, except at great cost, to so thoroughly clamp a diaphragm between metallic rings that at some point it would not be a little loose and produce a harmonic or other sounds not wanted when the diaphragm was regulated by the voice.

185

In EXHIBIT 37-42 the portions showing the india rubber rings consist:

1st. A ring marked "out ring," meaning the outer ring.

2nd. A disk marked "dia," which is the diaphragm.

3rd. A ring marked "in ring," meaning inner ring.

Next to this are two metallic rings represented between which is a diaphragm with the rubber rings on each side of the same.

Over these figures is the following instruction to my assistants:

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"Put rubber or other soft substance rings between the diaphragm on the rings."

"The instrument was made pursuant to these instructions, within one or two days after the date of the Exhibit.

We used the instrument, and about that time made many instruments with the diaphragm covered with rubber, near its edges on both sides. In the same Exhibit there are drawings of four diaphragms, resting upon a sheet of rubber, or other diaphragms stretched across a ring.

The diaphragm laid upon the rubber.

These diaphragms are formed of disks, with leaves extending from them, and also in the form of strips. Instruments containing these various forms of diaphragms, resting upon rubber, were made within a few days after July 29, and used.

The result was not so satisfactory, so far as the shape of the diaphragm is concerned as the diaphragm covered with rubber upon each of its edges.

These were compound diaphragms of two thicknesses, one of rubber, and the other of metal.

I have here a diagram, dated August 12, 1877, and signed by myself, and witnessed by my two assistants, Chas. Bachlor and James Adams.

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The second figure from the top shows the diaphragm resting upon two strips of rubber, and I mention underneath the figure, the following:

"Soft rubber to deaden the diaphragm, it
"works well, prevents harmonics or ex-
"cessive vibrations; hard pieces of rub-
"ber or equivalent could be placed in
"different parts of the diaphragm, and
"held against it by adjusting screws to
"dampen it."

These pieces of rubber held against the diaphragm, and made adjustable by screws to dampen it, is not shown in the figure, for in this case the greater or less dampening effect was produced by a greater or lesser stretching of the rubber strips passing over and in contact with the surface of the diaphragm.

The rubber performing the function of this spring or dampening finger as well as acting as a deadening material. (Diagram offered in evidence marked EDISON'S EXHIBIT 105-12.)

The sketch 105-12 shows the application of the dampener in connection with a receiver, not a transmitter, but

*rubber under
diaphragm*

the dampener will of course act the same with a transmitter.

About August, 1877, I constructed several telephones in which the diaphragm was loose and rested upon soft rubber near its edges, and was held there by two flat springs pressing upon the diaphragm near its edges. I have no drawing of the same that I have been able to find, but remember of having made instruments of this character.

I now make a drawing illustrating this instrument, showing the case, the rubber, and the spring fingers without the diaphragm.

191

Sketch offered in evidence and marked
EXHIBIT EDISON'S SPRING FINGERS, AUG., 1877.

This form of instrument was abandoned, as it was used as a receiver and the springs would catch in the hair of the person listening.

A short time afterwards, perhaps three weeks, we dispensed with the fingers, and made the ear of the listener perform the same function as the springs did, in holding the diaphragm against the rubber, and also dampening the diaphragm.

192

I produce one instrument made some time in Sept., 1877, showing this alteration. It consists of a loose diaphragm resting upon rubber. The diaphragm being adapted so as to allow it to be held against the rubber, and dampened by pressing the instrument slightly against the same.

Instrument offered in evidence, and marked
"EDISON'S EXHIBIT LOOSE DIAPHRAGM, SEPT., 1877."

The object of the little extension in the diaphragm was for the purpose of preventing it from falling off when taken from the ear; at the same time allowing the

diaphragm to be sufficiently loose, so that it was pressed against the rubber and dampened at the same time, when placed against the ear.

I think about 100 of these instruments were made about September, 1877, and sold and delivered to the Western Union Telegraph Company.

I have here a sketch dated August 20, 1877, signed by myself, and witnessed by my two assistants, Charles Batchelor and J. Adams.

In this sketch are two diagrams, one at the bottom of the page and one immediately over it; both show the diaphragm at loose and resting upon the rubber.

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(Sketch offered in evidence, marked EDI-
SON'S EXHIBIT 126-12.)

In the bottom figure no means are shown for preventing the diaphragm from falling off, but in the figure above it, extensions are shown bent over on the side of the case, as in EXHIBIT LOOSE DIAPHRAGM.

The diaphragm had a hollow core fastened to its center, against which the ear was pressed.

These forms were made and used within two or three days after the date of the exhibit.

I here produce one of several instruments made for transmitting musical sound. I think this one was made and used, certainly, before the 1st of September, 1877.

195

It contains a diaphragm with rubber rings on both sides, near the edges.

In addition to the rubber rings, there was a paper ring; in this case the diaphragm was held by a metallic ring resting upon the paper and screwing into the diaphragm holding ring.

Public exhibition of the transmission of musical sounds, with the aid of this instrument and others like it, were made by my assistant, E. H. Johnson, in different parts of the country.

The instrument described was made for use for trans-

mitting articulated sounds, but can be used for transmitting articulated sounds, when carbon electrodes or points are substituted for the platinum points.

(Instrument introduced in evidence and marked "EDISON'S MUSICAL TELEPHONE, SEPT. 1877.")

I next produce one of a lot of a large number made about sometime in August or September, 1877, which contains a loose diaphragm resting upon a rubber diaphragm, and dampened by a rubber finger, which is adjustable.

197 The adjustable finger also acts to increase or decrease the initial pressure between the two electrodes against the diaphragm, as in recent count, case 5.

It also meets the count in case 4, as there is a combination with a diaphragm of a telephone of a kind of yielding material around the edge and a dampening finger.

It also meets the 1st count of case 3, inasmuch as the diaphragm is held by means of a spring pressing against one of its surfaces, which spring is also a dampener.

(Instrument offered in evidence and marked "EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877.")

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In my application No. 178, the carbon material is between two springs, so as to allow the pressure to be applied to the carbon between such springs without preventing the vibration of the diaphragm.

In the Exhibit called EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, there are two electrodes with carbon between them. The one electrode towards the diaphragm is a spring, the other is rigid; but the diaphragm is provided with a spring in the form of a rubber tube,

which allows the pressure to be put on the carbon, and at the same time allows the diaphragm to vibrate freely, and this spring of rubber tube admits of my degree of initial pressure to be put upon the two electrodes, when moved to, and in contact with, the diaphragm.

If, as in my application No. 178, the weight of the electrode was connected rigidly to the lever *l*, the plugging of a rubber tube between the diaphragm and the spring *h*, would produce the same result; the rubber tube spring taking the place and performing identical functions with the weighted spring.

Again, in my application No. 178, the object of the arm *f* is to cause the electrodes to advance or recede from the diaphragm, so that the varying initial pressure between the two electrodes when brought in contact with the diaphragm can be made. This is accomplished by means of the screw *g*.

In the case of the instrument marked EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, the lever, so to speak, is made rigid, in the form of a screw bar, and the screw, *g*, is placed through its center and forms one of the electrodes, and being a screw will allow the electrodes to be adjusted to, and from the diaphragm putting on a greater or lesser initial pressure between the two electrodes.

If the cross-bar was pivoted at one end, and the screw which fastens it to the frame was made to raise and lower it, the design with that shown in application No. 178, would be identical, but the principal operation is the same without this pivot.

I think about 100 or 150 transmitters, of which EDISON'S ARTICULATING TRANSMITTER, OCT., 1877, is one, were made either in September or October, 1877, they were made by Mr. J. T. Murray, of Newark, by a order of the Western Union Telegraph Co., and delivered to the said Company soon after.

The lot that I here speak of were made exactly like the Exhibit marked EDISON'S ARTICULATING

*articulating
transmitter
Oct 77*

*Case 5
Case 4.*

2192 THOMAS A. EDISON.

TRANSMITTER, OCTOBER 1877. The Exhibit itself is marked NO. 37.

About September, 1877, an instrument was made and used almost precisely like that shown in my application No. 178, with the exception that the lever (*l*) was pivoted instead of being controlled by a spring. It was adjusted by a screw sliding on an incline. The spring (*j*) was fastened, not to the lever, but to the spring carrying the other electrode.

I have neither a drawing or model of the exact design, but I am certain that I made several forms of this kind.

In September 22, 1877, I made a drawing of a lever pivoted at one end and adjusted at the other by means of a screw, with a spring on the lever, but in this case the diaphragm acted as one spring and the lever as another.

This Exhibit is signed by myself and witnessed by my assistant, Charles Batchelor. I remember having made it, and I have a model somewhere in my possession, but it has been mislaid.

(Drawing offered in evidence and marked EDISON'S EXHIBIT, 36-13.)

The instrument shown in EDISON'S EX. 36-13 was used, and I believe a number of them with the electrode placed on the lever in different ways were made. In this case, EX. 36-13, the diaphragm acted as a spring on an electrode, while the lever acted on a spring in the other electrode. The lever getting its spring from the spiral around the adjusting screw. The operation of the device being the same as the operation of the device forming the second count of case 3.

In Exhibit marked EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, I desire to mention that it is not essential that the rubber should extend over the whole of the surface of the diaphragm, as the diaphragm rests at its edges upon the rubber, and is held against it by the dampening finger carrying the

THOMAS A. EDISON.

2195

electrodes, the diaphragm being then dampened on both sides by rubber.

Some time in September or October, 1877, I made an instrument which I produce.

Instrument offered in evidence and marked - EDISON'S THREE-SPRING ELECTRODES.

This instrument is substantially the same as that marked EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, with the exception that three springs made of platinum were used, between which were two carbons, the initial pressure between the platinum springs and the carbons was produced by a rubber spring tube on the diaphragm when the electrodes were brought towards it.

In the model the carbons have dropped out and been lost, and the rubber tube which was once fastened to the cork on the diaphragm has become disconnected and lost.

I produce a sketch made Oct. 2, 1877, by my assistant, James Adams, and signed by myself and Charles Batchelor, which shows in the figure nearest the edge on the left hand a pointed lever adjusted by means of a screw to and from the diaphragm. The electrodes being in this case the diaphragm of the lever.

A rubber tube is placed between the lever and the bridge back of the lever for giving a forward motion, and a screw upon the right hand side passing down through the bridge to the lever, and connected therewith at its end, causes each lever to approach or recede from the diaphragm and modify the initial pressure between the electrodes.

The cork was placed upon the diaphragm and laid a hole through it, in the bottom of which was a piece of platinum connected to one pole and a cap upon the lever, held the carbon which pressed upon the platinum.

My impression is that this instrument was made.

(Sketch offered in evidence and marked - EDISON'S EXHIBIT, 1-13.)

238 THOMAS A. EDISON.

I here produce a sketch dated Oct. 3, 1877, signed by myself and witnessed by my assistant, Chas. Batchelor.

(Sketch offered in evidence and marked "EDISON'S EXHIBIT 7-13.")

In the lower figure is shown a spring electrode resting on carbon, which in its turn rests on the diaphragm.

The two forming two-springy electrodes and greater or lesser initial pressure is placed upon the electrode by means of a springy rubber tube fastened to an adjusting screw moving in and outward at right angles to the electrodes, each screw performing the double function of altering the initial pressure between the electrodes and dampening the diaphragm.

The next figure shows the lower one shows a lever electrode, the sketch is not very full, but my impression is, that it was pivoted at one end, and is similar to the first sketch on the top of EXHIBIT 20-13, except that two rubber dampening tubes were inserted between the frame comprising the diaphragm and the lever, for the purpose of dampening the lever.

I here produce a sketch dated Oct. 5, 1877, signed by myself and Charles Batchelor.

(Sketch offered in evidence marked "EDISON'S EXHIBIT 16-13.")

It is precisely the same as the instrument shown in EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, except that instead of a hard vulcanized rubber disk, to which the spring is attached, a strip of rubber was used to hold the electrode.

The spring being quite stiff and able to sustain itself alone. It is as stiff as that shown in my application No. 178.

The soft rubber spring upon the diaphragm performing the same functions as if the rigid electrode was springy and the soft rubber tube rigid.

THOMAS A. EDISON. 211

In this device shown on EXHIBIT 16-15, we have two electrodes, between which is the carbon as in my application No. 178.

One, the electrode towards the diaphragm, consists of a spring, upon the ends of which is a disk of metal, this disk resting on carbon, which carbon rests on the other electrode, which is rigid, that is to say, it is not springy. This is not the case with the electrode in application No. 178, but the soft rubber tube upon the diaphragm renders it unnecessary to have the other electrode springy.

Were this rigid electrode springy, then the soft rubber tube might be dispensed with.

The initial pressure in both this and Application No. 178 is produced in substantially the same manner.

I think one instrument like EXHIBIT 7-13 was made as an experiment.

I think several instruments were made like 16-13. These were made within a few days after the date of the exhibits.

I here produce a sketch made Oct. 4, 1877, signed by myself and Chas. Batchelor.

(Sketch offered in evidence, and marked "EDISON'S EXHIBIT 9-13.")

The bottom figure shows the diaphragm as one electrode, and a lever resting on the diaphragm as the other electrode.

The initial pressure between the electrodes is regulated by means of a rubber on its extreme end, adjustable inward and outward at right angles to the lever.

In the upper figure shown in EXHIBIT 9-13, two dampening fingers are shown, which consist of two screws with rubber spring tubes at their ends, which tubes rest upon the diaphragm.

The screws being adjustable inwardly or outwardly, produce a dampening effect upon the diaphragm.

The following words are written upon the sketch when it was made:

214 THOMAS A. EDISON.

"Extra screws and rubbers to dampen the diaphragm."

Both instruments described in the sketch were made within a few days after Oct. 4, 1877, and tested, and they worked.

I have produced a sketch, dated September 21, 1877, signed by myself and Chas. Batchelor.

Sketch offered in evidence, marked "EDISON'S EXHIBIT 104-12."

215 At the bottom of the sheet is a sketch marked "Dampened Diaphragm." The following words written at the time are on that exhibit:

"Men diaphragm loose and laid against a
"stretched rubber diaphragm; this prevents the effect of expansion and kills
"harmonies, both low and high; it
"works beautifully. We made a lot
"of telephones this way, and they
"all showed that it did the biz, hunky
"don't."

216 I have produced a sketch dated November 2, 1877, signed by myself and James Adams.

(Sketch offered in evidence and marked "EDISON'S EXHIBIT 54-13.")

The figure at the top shows two spring electrodes, between which is a piece of carbon.

Motion and pressure was given to the electrodes by means of the diaphragm.

The initial pressure between the two electrodes being brought about by means of a screw.

The sketch shown is a mere outline to convey to some of my assistants the idea to be carried out on an instru-

THOMAS A. EDISON. 217

ment already made, and similar to that called Edison's Articulating Transmitter, October, 1877.

I will now proceed to make a sketch which will more fully explain the one made November 5, 1877.

(Sketch produced in evidence and marked "EDISON'S EXHIBIT, 54-13, AD DITIONAL.")

This corresponds with the second count in case No. 5. The instrument was made and put in use probably within a few days from the date of the exhibit.

218 89 Q. Counsel for Edison offers in evidence a copy of ENGLISH PATENT No. 2,909, dated July 30, 1877, granted to T. A. Edison for controlling by sound the transmission of electric currents and the reproduction of corresponding sounds at a distance (same marked EDISON'S ENGLISH PATENT, EXHIBIT 2,909), and asks the witness to point out therein the devices, in his judgment, corresponding with the issues in these interferences, cases 4, 5, 6 and 17?

A. Fig. 11 corresponds to the count 17, in which the subject matter is: "The spring carrying the electrode covered with rubber, or similar elastic material," inasmuch as the object of the soft material is to prevent the spring itself from vibrating to its proper musical tone, which it would do were not means provided whereby these vibrations were damped.

219 If the spring be combined with a soft substance, such as rubber, these vibrations are checked, and not transmitted.

In the early stages of my experimenting, soon after I devised the instrument shown in my PATENT 283,014, the vibration of the springs used in that instrument caused us considerable trouble by sending false vibrations over the wire.

These vibrations were soon afterwards prevented to a great extent by putting cotton around the springs marked 2" in said patent, and serving with a thread; also rub-

Micro dia
164-12

Eng photo

220 THOMAS A. EDISON.

ber tubes were used, molten beeswax was also poured over the springs.

The device shown in figure 11 of my BRITISH PATENT NO. 2,939 consists of an electrode spring in the form of a latter U, with a dampening material, "r," between the prongs of the u, and at the point where the greatest vibration would take place were the dampening material, or rubber not there.

Another object accomplished by this U spring was to present a somewhat flexible or giving contact point, so as to prevent a rebound of the diaphragm.

A band of wire was used to bind the two prongs against the dampening rubber r, which was afterwards changed for a band of rubber wound several times around the U shaped spring.

This was done about June or July, 1877.

In relation to the claims regarding the dampening of the diaphragm to prevent false vibrations, I will say, that in figure 2, of British Patent 2,000, the diaphragm was loose, and the ear was the dampener, as it was held against it in the act of receiving.

That in figure 10 the diaphragm was dampened by the electrode, and the same this the case with figures 9, 19, 23, 24 and 25.

That regarding the rubber around the diaphragm that patent states that "in some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm, so as to check or dampen any prolonged or false vibration, and render the sound more clear and free from prolonged tones."

This is shown in figure 18, but the reference in the specification to that figure, seems to have been left out.

I here produce the original of fig. 13, in my BRITISH PATENT 2,939, without the band around the fork, which was afterwards added. This sketch is dated June 25th, 1877, signed by myself and witnessed by Charles Batchelor and James Adams.

The drawing and writing was made at the same time,

THOMAS A. EDISON.

and the device, I think, was made within a day or two after making the sketch and of the date given.

(Sketch, offered in evidence and marked EDISON'S EXHIBIT 184-1.)

In December, 1877, and to the present time, diaphragms have been used by me, which have been dampened by dampening fingers of rubber, and also diaphragms covered on both sides near its edges with rubber and with dampening fingers, besides, have been used in telephones and invariably in phonographs, as far as I have had knowledge of the same; sometimes the transmitter of phonograph has had only dampening fingers, and others have had dampening fingers and diaphragms coated on both sides, near their edges, with rubber.

Public exhibitions have been given and instruments made and sold from February, 1878, to the present time containing these devices.

Q 30. Did you ever use a band of rubber or other similar elastic material applied to the disk of a telephone to cover the edges and lay upon both faces, and what device, if any, heretofore introduced by you correspond with the same?

A. I have used a band of rubber on each side of a diaphragm, near the periphery, each band lapsing over the edge and touching the other band, so as to form a diaphragm covered with rubber on both sides, near its edges and lapsing over.

I refer to EXHIBIT 191-41, and to EXHIBIT 37-32, as illustrating this mode of using the rubber at the edges of the diaphragm.

In connection with the phonograph instrument, I have used diaphragms which rested upon one side upon a circular band of rubber, and the diaphragm held against this band of rubber and its support by a circular ring formed of soft rubber tube, introduced between the diaphragm and the mouth-piece. I introduce a diagram illustrating the same.

(Sketch offered in evidence and marked "EDISON'S ILLUSTRATION DIAPHRAGM AND RUBBER TUBE DAMPER.")

I have another drawing which I here produce; it is dated May 25, 1877, signed by myself, and witnessed by James Adams and Charles Batchelor.

Drawing offered in evidence, marked Edison's EXHIBIT 99-11.

227 It operates in a similar manner to my Exhibit 42-11, in the case of Chalmers, with the exception that special adjusting screws are provided for the two springs carrying the electrodes to regulate the pressure upon the carbon and the electrodes against the diaphragm, as set forth in the 3d count in the official statement of case 3. I had such an instrument made about May 25, 1877. The instrument worked fairly.

In my caveat No. 76, filed March 8, 1878, fig. 62, two springs are shown with the electrode between them, and a spring between the same and the diaphragm.

In caveat on Photograph No. 77, filed in March, 1878, in figure 15 a diaphragm is shown with rubber rings at each side near its edges.

228 I produce the diaphragm of a telephone I made on the 23rd of March, 1877, in which there is a lever retracted by a spring, and adjusted by a screw, and having a second spring, the circuit being connected to the spring and lever respectively, and the spring intervening between the lever and the diaphragm. Four sets of lever springs and diaphragms are shown. By this means the two circuit electrodes were made to approach and recede from the diaphragm in the same manner as in my application No. 178.

An apparatus like that was made, and my intention was to send it to the Patent Office, and apply for

a patent on the same, but I cannot find that I have done so.

(Caveat for Mr. Edison offers the same in evidence, and it is marked EDISON'S EXHIBIT INSTRUMENT, 6-11.)

Q. 91. Your application 188, filed Dec. 31, 1879, involves the following subject matter:

"In combination with a diaphragm or other device for producing air waves, a device connected with said diaphragm or its equivalent, and causing the vibration of the same, by vibrations produced by vibrations of electro magnetism by the friction between two surfaces moving in contact with each other."

"In combination with a diaphragm of a receiving telephone, or rotary magnetized bar, an arm connected to the diaphragm and resting upon said bar and a helix around said bar in the circuit to the transmitter."

Please state the origin of your invention of said improvement in Telephones.

A. I conceived the idea in August, 1876, of an iron bar or core constantly rotated, and surrounded by a helix which was not rotated, and an arm resting upon the surface of such bar, the arm being of iron and connected to a lever which opened and closed the electric circuit substantially the same as shown in application 188, except that the lever resting upon the rotary iron bar was not connected to a diaphragm.

Q. 92. Have you any drawing of the same; if so, please produce it.

A. I have a drawing which I now produce, this is not dated, but is contained in a note book of experiments, all of which are dated in various places, August, 1876. The experiments in this book relate to that class of apparatus analogous to this exhibit, having paper or chalk upon which the arm rests instead of iron as in my application for a patent on Electromagnetograph.

case 478
188

230

Aug. 1876

231

Case 76

No 77

Electro-metograph

Counsel for Edison offers the drawing in evidence to be marked "EDISON'S ELECTRO-METOGRAPH RELAY, AUG. 1876."

The three sheets relating to the same are now torn out of the book, and the book tendered to counsel contradictory to dates. These Exhibits are also marked 320-S, 321-S, and 322-S.

By consent of counsel the written matter is transferred to the record as follows:

"AN IDEA."

"The idea has occurred to me that the E. M. G. principle of working by a difference in friction might be applied to an electric magnet. I took a magnet, extended one core by placing an armature upon it, and by opening and closing the key and passing along a flat-tined iron wire the clump produced by the friction caused by magnetism and the normal friction was apparent. I propose to embody this principle in a machine thus: — — —"

"Of course this arrangement isn't exactly like the principle of the E. M. G.—*i. e.*, working by difference of friction. Its principle of increasing delicacy of magnetic relays by working in actual contact when the end of the iron core has a ring of ivory of considerable thickness, to prevent the effect of accidental magnetism, it will be noticed that the power with which the relay lever moves is always the same; no addition over a certain amount can change the adjustment. In fact this principle opens a new field in magnetic telegraphy and in electro-mechanics."

Q. 92a. In whose handwriting is the written matter upon the said exhibit?

A. In my handwriting.

Q. 92. And to the best of your knowledge and belief when was that written matter made?

A. About August 9 or 10, 1875.

Q. 93. Did you also make the drawings yourself?

A. Yes, sir.

Q. 94. In your patent 178-787 for an electro-metograph, Jan. 10, 1875, a moving surface is made use of to communicate varying motions to another body, according to the electric current passing between the two surfaces, in what respect does that correspond with, or differ from the drawing shown on the exhibit, you have here produced?

A. In the patent 158,787, the varying motions are produced by a lessening or increasing of the friction between the two surfaces by electricity, while in the exhibits the difference of friction is produced by magnetism.

Q. 95. Referring to your patent 221,957, granted Nov. 25, 1876, and applied for March 21, 1879, please state what, if anything, is the difference between the device therein referred to, and the subject matter of the present interference?

A. Both instruments work by a difference of friction between surfaces produced primarily by electricity, but in the case of patent 221,957, the electricity acts directly between the surfaces to produce friction, while in the case of this interference the electricity produced magnetism, and this alters the friction between the surfaces.

Q. 96. About how long before filing your application March 31, 1879, for Patent No. 221,957, had you been experimenting upon a telephone in which the friction produced by electricity had been made use of to give motion to the diaphragm from a moving body?

A. In the early part of 1877 I commenced to experiment in this class of invention.

Q. 97. When and under what circumstances did you first make an instrument containing the precise subject matter of those two interferences?

A. The instrument containing the precise subject matter in relation to a telephone was made and operated, I think, about Feb. 1879.

Q. 98. Please state what workman made the same, and how you are able to fix the date?

A. The instrument was made by my nephew, Chas. P. Edison, and I fix the date by referring to his records of experiments made to perfect the chalk telephone, or motograph telephone, according to my patent N. 221,577. He started experimenting, as near as I can remember, in Sept. 1878, on motograph telephones, and continued such experiments up to about March, 1879, when he left for Europe. It was a month or so previous to his departure that he made the instrument in interference. Chas. P. Edison never returned; he died in Paris, a few months after his arrival there.

Q. 99. Have you been able as yet to take the time for collecting together and asserting your drawings and sketches relating to this motograph telephone?

A. I have not.

Q. 100. Have you been able as yet to find the drawings of this particular instrument or instruments made by Chas. P. Edison, previous to his departure for Europe?

A. No, sir.

Q. 101. Are you able to produce any original drawings representing the precise subject matter of these interferences?

A. Only one, which I now produce.

Drawing offered in evidence, marked
EDISON'S EXHIBIT 169-14.

102 Q. Please state when this drawing was made and what is shown upon it?

A. This drawing, I think, was made about July, 1879; it is dated July 16, 1879, and witnessed by Chas. Batchelor and John Kruetz; it is marked as magnetic telephone, it is a bar of iron which is rotated by a handle;

this bar passes through a helix of wire not rotated; on the surface of the bar at one end is an iron layer resting upon the surface at one end and connected to the centre of a diaphragm at the other end, and it is all respects the same as in my application No. 188.

103 Q. Is there anything upon that sketch, EXHIBIT 169-14 beside this motograph telephone receiver, and state whether or not there is anything that enables you to know whether or not this is a drawing from which Chas. P. Edison made the instrument as spoken of before in your testimony?

A. Yes, there is an induction coil, a cell of battery and a carbon inertia transmitter. I am certain that Chas. P. Edison did not make his instrument from this drawing, as the form of transmitter shown in this drawing was not in use when he was here. My impression is that this drawing was made by me as explanatory of this instrument which he made to some person who I was endeavoring to illustrate the principle to, I naturally using the transmitter now in vogue.

104 Q. Returning now to the instrument made by Chas. P. Edison about February, 1879, please describe the same, and if it was made in more than one form, state the different form, and tell us whether or not any of the instruments made by him were actually made use of in receiving articulate speech?

A. The instrument shown in EXHIBIT 169-14 was identical with one form which he made. I will now proceed to make a drawing of another form which I remember he made and tried.

Drawing made and offered in evidence
and marked "EDISON'S EXHIBIT
MAGNETIC MOTOGRAPH TELEPHONE."

105 Q. State what, if anything, is the difference between the instrument shown on exhibit and the instrument shown on EXHIBIT 169-14?

A. In the instrument shown on EXHIBIT 163-14, the friction was produced by direct magnetic attraction between the moving magnet bar and the lever connected to the diaphragm, while in exhibit called EXHIBIT MAGNETIC MOTOGRAPH TELEPHONE, the friction was produced by magnets, but not directly, but through the action of a lever resting upon a rotating bar, with force being applied to press upon the rotating bar with greater or lesser pressure, as the electro magnet was energized in a greater or lesser degree.

103 Q. Did either of these telephones receive articulated speech?

A. Yes, sir.

107 Q. About how often were they tested and over about what period?

A. They were tested perhaps a week, different alterations being made upon them all the time, the results were not considered sufficiently satisfactory compared to the plans which we were working on, and shown in my patent 221,057, and we laid the matter aside until the instrument shown in my patent 221,057 was patented.

108 Q. About how many instruments in all have you made containing the precise subject matter of these present interferences?

A. I think two were made.

110 Q. And how many alterations, if any, were made to those two instruments?

A. A great many alterations were made, so as to improve the volume of sound, so that it would compare favorably with the plan described in my patent 221,057.

112 Q. Who, if anyone, knew of the construction and use of these instruments containing the precise subject matter of these interferences besides Charles Edison, who is now dead.

A. I think Charles Batchelor, Francis Upton, and John Ott know something about the experiment.

114 Q. In the sketch which you have placed in evi-

Motophone

dence, marked "EDISON'S ELECTROGRAPHIC RELAY, AUG., 1876," you have represented the apparatus as being adapted to the opening and closing of a secondary circuit for a Morse sounder or other similar instrument, have you not?

A. The motion produced was utilized for that purpose that is, opening and closing a local circuit; in this case the diagram is illustrative of the principle.

112 Q. When was the first instrument constructed, experimental or otherwise, in which this principle of varying the friction between two surfaces by the increase and decrease of an electric current, in a circuit acting through the electro magnet?

A. The first instrument constructed where the increase or decrease of friction was produced by electro-magnetism, by varying the strength of an electric current in a circuit without totally breaking the circuit, was made about February 1875.

113 Q. Was the instrument you now refer to the same one which you have testified to having been made by Charles P. Edison?

A. Yes, sir.

114 Q. Is that instrument now in existence?

A. I think not. I think it has been taken apart and my assistants are now looking for the parts.

115 Q. You have stated that two instruments embodying this principle in different forms were made by Charles P. Edison; which of those two forms which you have described was first constructed?

A. I think the one made precisely as the one in interference and shown in my EXHIBIT 163-14.

116 Q. Did both of these instruments articulate speech intelligibly?

A. I am quite sure the one shown in EXHIBIT 163-14 did, but I am not sure as to the other form as in EDISON'S EXHIBIT MAGNETIC TELEPHONE.

117 Q. By whom were the tests of this instrument made?

A. I think by Charles P. Edison and Charles Fletcher.

Q. 118. Can you state what kind of a transmitter was used in connection with this instrument as a receiver during these tests?

A. Yes, sir; it was a regular Edison Carbon transmitter.

119 Q. You have said, referring to the tests of this instrument, that the results were not considered sufficiently satisfactory, compared to the plans which you were then working on and shown in your patent 221,057, will you please state more definitely in what particular the results were unsatisfactory or defective?

A. It was not as loud as the plan shown in patent 221,057, hence we had it made for the time being to perfect the plan shown in the patent.

Q. 120. Can you give approximately the date at which the experiments with this apparatus were discontinued?

A. I think in February, 1879, we stopped working the instruments.

Q. 121. Between the month of February, 1873, and the time of your application, Dec. 31, 1879, was any time devoted, and if so, how much, in relation to telephones in which the diaphragm was moved by friction between an arm extending from the diaphragm and a moving surface?

A. I had several men working on telephones working on friction between an arm on a diaphragm and a moving surface, but no work was done, I think, on the plan where the friction was regulated by magnetism.

Q. 122. Did you, in any manner, abandon your invention of magnetic magnetograph telephones now in interference, either by expressly stating that you gave the same to the public or otherwise?

Counsel object to the above question as leading.

A. No, sir. I have verbally testified that I laid the

*Carbon
transmitter
used with
Microphone*

matter aside for the time being, desiring to first perfect the plans shown in my patent No. 221,057.

Q. 123. Is there or not any substantial difference between this instrument made for you by Chas. P. Edison in the early part of the year 1873 and the instrument shown in your application No. 183, filed Dec. 31, 1879?

Same objection.

A. No, sir; no difference between one form that he made and the application.

Q. 124. State whether or not you have yet been able to find either of the original instruments that you have referred to in this case?

A. They have not yet been found.

Q. 125. State whether or not in either of the instruments made by Chas. Edison, the revolving core was permanently magnetized?

Objected to by counsel as leading.

A. Yes, sir; in one case it was.

Q. 126. What was the object of permanently magnetizing that core?

Same objection.

A. The object was to produce an increase and decrease of a constant magnetic field.

127 Q. Please introduce any other exhibits you may have made in the year 1877, which you may think advisable as either bearing upon the general question now in issue, or as showing your diligence up to the time of your application made in December, 1877, and now in this interference?

A. I here present the following exhibits:
1-12, 13-12, 7-12, 9-12, 10-12, 11-12, 12-12, 13-12, 14-12, 15-12, 16-12, 17-12, 18-12, 19-12 (drawing portion only), 24-12, 25-12, 27-12, 28-12, 31-12, 32-12, 33-12, 34-12, 36-12, 38-12, 44-12, 45-12, 46-12, 47-12, 48-12, 51-12, 53-12,

54-12, 55-12, 56-12, 57-12, 58-12, 59-12, 61-12, 62-12, 63-12, 64-12, 67-12, 68-12, 69-12, 70-12, 72-12, 73-12, 74-12, 76-12, 77-12, 78-12, 83-12, 84-12, 85-12, 86-12, 87-12, 88-12, 89-12, 90-12, 91-12, 92-12, 93-12, 94-12, 95-12, 96-12, 97-12, 98-12, 100-12, 111-12, 112-12, 115-12, 116-12, 119-12, 121-12, 123-12, 124-12, 127-12, 129-12, 131-12, 132-12, 133-12, 135-12, 138-12, 142-12, 143-12, 144-12, 145-12, 146-12, 147-12, 148-12, 151-12, 152-12, 154-12, 159-12, 160-12, 161-12, 162-12, 163-12, 166-12, 167-12, 168-12, 171-12, 173-12, 174-12, 176-12, 179-12, 177-12, 178-12, 179-12, 181-12, 182-12, 183-12, 184-12, 185-12, 186-12, 189-12, 192-12, 193-12, 194-12, 195-12, 196-12, 197-12, 198-12, 199-12, 200-12, 201-12, 202-12, 203-12, 204-12, 205-12, 206-12, 207-12, 208-12, 209-12, 210-12, 211-12, 212-12, 213-12, 214-12, 215-12, 216-12, 217-12, 218-12, 219-12, 220-12, 221-12, 222-12, 223-12, 224-12, 225-12, 226-12, 227-12, 228-12, 229-12, 230-12, 231-12, 232-12, 233-12, 234-12, 235-12, 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986-12, 987-12, 988-12, 989-12, 990-12, 991-12, 992-12, 993-12, 994-12, 995-12, 996-12, 997-12, 998-12, 999-12, 1000-12.

Q 128. Please state whether there are in this last lot of exhibits you have produced, any that you desire to explain further and state in that same connection what your object has been in introducing the written exhibits?

A. My object in introducing these exhibits is to show my diligence in perfecting the principle of telephonic transmission, by varying the resistance of a closed circuit, by a body set in motion by the human voice, and that I never gave up or abandoned any of the many devices in

*Intelligence
shown
by Exhibits*

which there was the slightest hope of attaining the object, that although a certain device might be laid aside for a time, these exhibits will show that I again and again took up the subject and continued further experiments, every advance in the art made by me, while any one device had been laid aside temporarily, caused me to take up the thing again, most of the exhibits will explain themselves, but if any further explanation is required by the parties in this interference, I will give it.

Q 129. Please describe what EXHIBITS 1-12, 43-12, and 80-12 specially indicate?

A. EXHIBIT 1-12 illustrates a telephone instrument for transmitting which consists of a rapidly revolving wheel in front of a diaphragm, and a spring resting upon the periphery of the revolving wheel, and also connected to the center of the diaphragm, the wheel forming one electrode and the spring the other electrode. Contact surfaces, in rapid rotation, offer a resistance to the passage of the current the amount of the resistance depending upon the surface velocity, and the pressure of the spring, the idea was that the vibration of the diaphragm would cause a greater or lesser pressure between the spring and the periphery of the wheel to take place, and thus vary the resistance of the circuit. This instrument was made July 1, 1877. It did not work satisfactorily.

On EXHIBIT 43-12 the following is written:

"We find that we must go back to the old
"spring arrangement to prevent violent
"stoppage of the diaphragm. This time
"we put spring on the diaphragm thus"

The sketch below illustrates how the spring was put on the diaphragm. This sketch was made July 22, 1877, signed by myself and witnessed by Chas. Behneler and James Adams.

EXHIBIT 80-12 has the following written upon it:

"I can get articulation with a platinum point transmitter, by putting in a relay at the distant station and shunting around it, so as to toll the vibrations; also, can do same thing by shunting receiver with a condenser."

The platinum point used in this case upon the diaphragm was flexible; the point extraneous to the diaphragm was rigid. This is an attempt to make a Edison transmitter slightly modified—transmit articulate speech.

The diaphragm which I speak of is the one on the top of the page.

Q. 130. What, if any, difficulty had you experienced in the use of platinum contact point in telephones?

A. My experience was that a Edison telephone, with a platinum contact, did not and would not transmit articulated speech in a sense that would make it a commercial instrument.

Q. 131. During these numerous experiments, did you, from time to time, confer with Mr. Orton, president of the Western Union Company; and if so, was there any particular thing which he wanted to have accomplished in connection with the acoustic instruments?

A. I conferred with Mr. Orton in regard to these experiments a great many times, and took apparatus over to the Western Union Telegraph office and set them up, and had him work them or listen to them. His general reply was:

"You are doing well, young man; keep right on."

The instrument of March 25, 1877, he listened to, and refused to accept it as a perfect telephone, because he said it was not loud enough, and that it was not clear enough. But told me to keep right on.

One article of Mr. Orton was his dislike of the use of soft rubber in a telephone, or in any telegraphic instrument. He said he had been in the rubber business and

Orton

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rubber
rejected to

knew all about it, and that it was unreliable, and that he would not have my instrument with soft rubber in it.

Q. 132. Did you at any time put any of the telephones shown in either of these exhibits into use, for business purposes; if so, about when?

A. I think I put some telephones in practical operation in New York, in August, 1877, between the office and yard of a lumber dealer, and on other lines which I cannot now remember. These telephones were carbon telephones, in which the resistance of the local circuit was varied in its resistance by the pressure of the diaphragm in vibrating. EXHIBIT 132-12 shows one of the forms made at that time for public use.

I used the same kind of receiving instrument as that made by me in Nov., 1875, which consisted of a diaphragm, an electro magnet serving to give motion to the same. The diaphragm was of iron.

Q. 133. Have you from time to time made, or permitted to be made, publications in relation to your improvements in telephone instruments, and if so, state generally what the publications have been?

A. Yes, sir; I have made publications relating to my work on telephony. I have present an Exhibit marked "MOTOGRAPIH PUBLICATION," printed in the N. Y. Daily Tribune, May 4, 1877.

EXHIBIT 87-11 was prepared by me at the instance of a Tribune reporter, soon after the publication of May 6, in which I did not give him; it was to be a cut matching the size of the Tribune column, and represents my speaking telephones with carbon points and motograph receiver.

The reason I did not give it to him was the fear that its publication would hurt my foreign applications.

Q. 134. Please state whether or not publications have been made, from time to time, of your improvement in telephones, or of any public exhibitions of either the speaking or the musical telephone, and if so, state when those publications were made, and in what papers?

Hand for
business
Chig 1877
reviewed
in 1875,

306

307

208 THOMAS A. EDISON.

Adjourned to Thursday, Nov. 11, 1880, at 10 1-2
o'clock A. M.

S. L. G., Notary.

Laboratory of T. A. Edison,
Menlo Park, New Jersey.

THURSDAY, Nov. 11, 1880.

Met pursuant to adjournment.

Same parties present.

209 Examination of T. A. Edison, Esq., continued.
A. I think I have several such publications and will
have search made for them.

The following publications are referred to as Exhibits
in this case, and the particular articles are reprinted in
the book of the Exhibits:

Publication A. Edison's Pressure Relay.
Journal of the Telegraph, June 1, 1877, page 163.

Publication B.
Telephonic inventions, descriptions of the inventions
of Bell, Gray and Edison.

270 In Philadelphia Press, July 9, 1877.
In the Journal of the Telegraph, New York, July
16, 1877.
This article was also published in other papers, E. G.
Scientific American.

Publication C. The Edison Telephone.
In the Sunday Trojan, Troy, New York, September
2, 1877.

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Publication D. The Telephone Concert.
In the Chester, Pennsylvania, Evening News, Sept.
28, 1877.

Publication E. Programme of Grand Exhibition of Edison's Tele-
phones, Oct. 18, 1877, at the Talcottville, Jersey City.

Publication F. Testing the Telephone.
In the Daily Graphic, April 17, 1878.

Publication G. Genius before Science.
In the Washington Post and Union, April 19, 1878.

Publication H. The Telegraphic Journal, Jan. 1, 1878, page 1.

Publication I. Academy of Science.
In New York Daily Tribune, April 30, 1878.

Publication J. Telegraph and Telephone.
In the Daily Graphic, April 30, 1878.

Publication K. Scribner's Monthly for April, 1878, page 853.

Counsel for Gray objects to each and every
of the above publications as evidence of
their having been published at the times
and places alleged, or of the facts therein
stated.

Q. 135. Please state what the undated EXHIBITS
111-15 and 118-15 are made to illustrate?

Publications

A. The apparatus sketched in 111-15 consists of a screw with eye for holding carbon and forming one electrode of a circuit, and a spring resting upon such carbon permanently and connected to the other part of the circuit and forming the other electrode, and a spring between the diaphragm and electrodes in the form of a short piece of rubber tube, whereby the initial pressure between the two electrodes can be varied by the adjusting screw, and when in their proper position variations take place by the vibrations of the diaphragm.

Such apparatus was made, in fact, a number were made.

276 This apparatus was made the last of August or first of Sept., 1877.

I was enabled to ascertain this fact by reference to EXHIBIT 177-12, Sept. 24, 1877.

The sketch shown on the bottom of 118-15 represents the electrode of a musical transmitter, consisting of a diaphragm, a platinum point facing a spring adjustable, between its support and the spring is placed a piece of rubber tubing to prevent a rebound of the spring electrode.

This instrument was made either in June or July, 1877.

It is a modified Reis transmitter.

278 Q. 138. Have you ever made use of a diaphragm of very thin sheet metal, which required to be stretched in order to be used; if so, when and with what results?

A. I have used a diaphragm of exceedingly thin sheet iron, which required to be stretched, as far back as December, 1876.

It was used as a receiver.

The ungut stretched it so that it became useless.

I have also used the same in connection with a transmitter in 1876. I think, perhaps, August, 1876. I have used diaphragms of all thicknesses from thin tin, which had to be stretched, up to material which it was unnecessary to stretch.

I have used some diaphragms one-quarter of an inch thick.

A diaphragm which retained its shape without requiring to be stretched were first used on my EXHIBIT A AND A'. These were iron.

Q. 137. In your opinion, after the numerous experiments which you have made, a diaphragm made of very thin sheet metal, so thin that it required to be stretched, capable of use successfully in the ordinary telephone instruments required for business purposes; and give your reason for any opinion?

A. Such a diaphragm is not practicable for business purposes except some means are provided whereby the diaphragm is under constant tension so that any expansions or any stretchings of the metal will be taken up by these means. If no means are provided, but the diaphragm originally stretched supported with means for future compensation then the effect of the sound waves and wind rushes in the act of speaking will stretch the diaphragm and buckle it, so that its centre will be out of the line in which it originally was when first stretched.

There will also be extra sounds given out by the diaphragm and transmitted when used as a transmitter, due to the loose character of the diaphragm.

Q. 138. In your opinion is a metallic diaphragm of a telephone practically useful made of thin sheet metal attached around its edges to a case and in which the thin sheet metal has numerous buckles and inequalities that prevent the surface being a true plane?

A. No, sir; I do not think such a diaphragm is practicable if the metal is very thin and it has these buckles. It would be very difficult to keep the circuit controlling electrode in adjustment with relation to the diaphragm. It would also transmit extra waves, due to the action of air rushes from the mouth upon the diaphragm in the act of speaking.

Q. 139. Suppose an instrument is made with a case into which the sound is directed, a diaphragm of thin sheet metal stretched over the end, and a rigid contact

*Undated
Sketches
described*

*Thin sheet
now dia.
Dec. 75
transmitter
Aug. 1876.*

*Thin metal
Sketches not
good*

point opposite the centre of the diaphragm so that after a small amount of use the point penetrated the thin sheet metal, could such an instrument be practically used as a telephone?

A. I should say that it would be self-evident that it could not be used practically.

Q. 140. If an acoustic instrument is adjusted in such a manner that the vibration of a diaphragm under the action of air waves produce an electric spark between a contact point and the electrode on the diaphragm, is such an instrument adapted to correct reproduction by a magnet and diaphragm at the receiving station of articulate speech and if not, why not?

A. Not when a spark is being produced.

If a spark is produced the metallic continuity of the circuit must be interrupted. If the break in the metallic continuity of the circuit was due to and represented the fundamental notes in the speech and not the action of momentum then the sounds produced by the fundamental vibrations would overpower the secondary or inferior vibrations. If such vibrations are sent at all on such an instrument, and as all these secondary and tertiary vibrations although very faint or weak compared to the primary or fundamental vibrations, are still necessary to the transmission or reproduction of articulate speech.

Q. 141. Did you, at any time, furnish material for the work known as the Speaking Telephone and Talking Phonograph, by Geo. B. Prescott, if so, what portions relating to the telephone researches did you furnish?

A. I furnished the basis of the article in Chapter VI, page 218, of the 1878 Edition.

Q. 142. Please state briefly the action of carbon when introduced in an electric circuit, and exposed to pressure or motion resulting from the movement of a diaphragm Does the rise and fall of electric tension depend upon pressure alone or does the surface contact, or the variation of surface contact incident to motion form an element?

A. The action is due almost entirely to surface action. If a button of compressed lamp black, or of any known material which conducts electric current, and finely divided or powdered, and moulded into a button, and placed between two electrodes in an electric circuit, or a solid button of metal, the surfaces of which are coated with a layer of finely divided conducting material, or if the surface of the solid button be roughened, so as to present innumerable points, and placed between two electrodes, in a closed electric circuit, a certain initial pressure of the two electrodes upon the two sides of the button will allow the electric current to pass from the electrode on one side, through a number of points to the button, and thence through the button out through points to the other electrode.

If the pressure between the electrodes be now increased, a greater number of points will come in contact with electrodes, and a greater number of points will be pointed for the passage of the electric current.

If the pressure is still further increased, more points will come in contact, a greater number of points will be prevented for the passage of the electric current, hence at every increase of pressure the electric resistance of the electrodes and buttons, as a whole, will be decreased; if the surface of the button between the electrodes is formed of very coarse particles, a compression due to a vibration of diaphragm, will diminish the resistance by throwing in circuit a greater number of points for the passage of the current, and a wave will be transmitted through the circuit corresponding in time and amplitude or energy of the sound wave striking the diaphragm; but in the case of a surface formed of very fine points the purity of the wave will be affected, because the electro magnet of the receiver, when the particles are very coarse, is capable of reproducing the passage of one coarse point, and another in contact with the magnet, and the wave, instead of being pure, is made up of a number of elong vibrations or grating sounds, which might be represented graphically by the teeth of a saw, the whole of the saw representing the wave, while the teeth represent the contact

*Elastic
spark.
See. valuable*

*Carbon
action
of*

*Chap. 6.
Prescott*

of the hundreds of these points with the electrodes in this as of vibrations.

If now the contact surface of the button between the electrodes is formed of conducting matter twice as fine, the wave will be more pure, and may be represented by the saw tooth twice the number and half the height, but the effect on the magnet will be in a greater proportion towards reproducing the wave free from these extra vibrations, because the charging and discharging times of the magnet varies as the rapidity of the vibrations are increased.

If now a lamp black button is used, we have matter in the finest divided state known, hence the magnet is totally incapable of giving a sound or rendering audible a change in the resistance of the circuit, due to the contact of one particle of lamp black after another, with the electrode, and it is estimated that there are over twenty million of contact points on the surface of a lamp black button one inch in diameter, and while a magnet might detect and render audible these internal contacts where there are only several hundred particles, it could not do so in the case of lamp black where several million vibrations are transmitted in the circuit, even if it could such a rate of vibrations be beyond the limits of audibility, just as we decrease the size of the carbon button or finely divided surface, just to that extent do we approach nearer to a point where these internal contacts are rendered audible, causing each wave transmitted to be made up of other waves producing higher articulation.

Experiments have been conducted by myself and by others, especially by Mr. Richards, of Colt's Armory, at Hartford, in the early stages of my carbon telephone, to ascertain if any of the diminution of resistance by compression was due to the compression of the mass itself, and not of the surface, but no diminution of resistance could be obtained, even by great pressure, the whole effect being due to the pressure upon the surface.

The pressure upon the surface producing more or less

intensity of contact, or a greater number of routes for the passage of the currents between the electrodes and the carbon.

Q. 143. In some of your exhibits mention is made of fluff; please state what that was, and how you used it?

A. What is meant by "fluff" is a small quantity of fibrous material, the fibres of which are coated with plumbago, or other inferior conducting material, and made into a disk and placed between two electrodes in a closed circuit, the object being to allow of a free vibration of the diaphragm, owing to the elasticity of the disk of fiber, and also to present a greater surface for contacts.

There was a certain amount of initial pressure between the electrodes and the fluff, the result of the compression of this fluff by a movement of the diaphragm was to bring a greater amount of conducting material in circuit by the contact of the conducting surface of the fibres with each other.

My patent 263,015, April 30, 1878, filed August 20, 1877, contains a fluff, which is called in the specification an "articulator or electric tension regulator." This acts to bring in a greater number of routes for the passage of the electric current when compressed by the vibration of the diaphragm, as with the carbon button. Theoretically, the action is analogous, but, mechanically, it is slightly different. The effect with this and with the carbon button is to vary the resistance of the circuit by the vibration of the diaphragm.

In my telephone with a carbon button as now used, the diaphragm is not free to vibrate; but in the patent 263,015 the diaphragm is provided with an elastic spring, and the articulation being elastic, allows the diaphragm to vibrate and at the same time dampen the action so as to prevent extra sounds being transmitted.

Q. 144. Can you furnish any useful instruments corresponding with any of the exhibit drawings in addition to the EXHIBITS 112-21. EDISON'S CUP AND CALIBER, 112-11; WEIGHTS, 112-11; EDISON'S MUSICAL TELEPHONE, SEPT., 1877; EDISON'S

fluff

292 THOMAS A. EDISON.

CARBON TELEPHONE, EDISON'S EXHIBIT THREE SPRING ELECTRODES, OCT., 1877; EDISON'S ARTICULATING TRANSMITTER, OCT., 1877.

EDISON'S EXHIBIT SPRINGS 42-41.

EDISON'S DIAPHRAGM 165-12.

EDISON'S EXHIBIT DIAPHRAGM 17-13.

EDISON'S EXHIBIT SPRING, MARCH, 1877.

EDISON'S EXHIBIT MICA DIAPHRAGM.

EDISON'S EXHIBIT LOOSE DIAPHRAGM, SEPT., 1877.

A. I here produce an instrument made about Feb. 17, 1877, marked EDISON'S EXHIBIT INSTRUMENT 14-11.

293 This instrument is illustrated in SKETCH 14-11.

It consists of a number of thin strips of metal, their tension being adjustable, the whole forming a sort of a diaphragm placed in front of a box in such a manner that speaking into the box would set the strips in vibration.

Platina points upon the end of contact screws formed one electrode, and the strips the other electrode.

A contact screw was adjusted in front of the strips; each strip was provided with a contact screw. All of the screws were connected through resistance with the circuit. This was an attempt to vary the resistance of a circuit by a multiplicity of contacts.

I here produce a portion of an instrument, marked EDISON'S EXHIBIT INSTRUMENT 16-11.

294 This device is shown in EXHIBIT 16-11, February 11, 1877, bottom figure, right hand corner.

This also was an attempt to vary the resistance of a circuit by a multiplicity of contact points, as more fully set forth in my patent 265,013 figures 1, 2 and 3.

I here produce an instrument, marked EDISON'S EXHIBIT INSTRUMENT TELEPHONE RELAY 28-11.

One half dozen of these instruments were made, and the description of this instrument is published in the

THOMAS A. EDISON.

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Journal of the Telegraph, which is here offered in evidence, and marked JOURNAL OF TELEGRAPH, JUNE 4, 1877.

I here produce EXHIBIT 160-11, which is a spring, corresponding to the spring in the DRAWING EXHIBIT 160-11.

I think the spring was made previous to May 25, 1877.

It carried a carbon cylinder, resting against a diaphragm.

As a transmitter, the instrument of which EXHIBIT 160-11 is a part, operated well.

I here produce an INSTRUMENT marked 120-11. That instrument was made as near as I can remember in May, 1877—portions of this instrument are shown in EXHIBIT 140-11.

The transmitter consisted of a diaphragm and a flexible electrode carrying a carbon cylinder.

The receiver was based on the autograph principle, the same as shown in my BRITISH PATENT 2509 figure 3, and subsequently carried out more fully in my patent No. 221,057, dated Nov. 25, 1879, filed March 21, 1879, described and illustrated in the New York Tribune of May 6, 1877, and further carried out in the exhibit which I now produce, which is marked "EDISON'S EXHIBIT MOTOPHONE."

The instrument I here produce marked "EDISON'S EXHIBIT INSTRUMENT 25-12," OCT. 17, 1877, corresponds to the device represented in EXHIBITS 21-12, 22-12, 23-12 and 24-12.

This instrument had a carbon button placed between an adjusting screw and the lever of the diaphragm, and provided with a spiral adjusting spring, so that the initial pressure between the electrodes and the carbon could be regulated.

The diaphragm which was of iron was polarized north by the U shaped permanent magnet, while the iron lever forming one of the electrodes was polarized south by the same magnet, hence there was an attraction between the

diaphragm and the iron electrode arm or lever, which in a state of rest was constant.

In the vibration of the diaphragm, which in this case was perfectly free, it never coming in contact with anything, its approach and recession from the iron lever electrode produced more or less attraction upon it, contrary to that of the spiral spring, hence the initial pressure upon the carbon button was varied at each vibration.

This instrument worked but was not loud.

I here produce an instrument, marked 67-13, made about Nov. 6, 1877.

299 This instrument consisted of two screws on each side of a spring, on the extremity of the screws were cups containing carbon buttons.

Upon the end of the springs were little pieces of felt, on each side, faced with platinum.

This apparatus was for sending reverse currents.

In the SKETCH 67-13 the end of the spring is shown as connected to the diaphragm.

This corresponds in its action to the device shown in my application NO. 141, filed July 20, 1877.

EDISON'S EXHIBIT INSTRUMENT 102-13 corresponds with the resistance coil shown in the middle figure on EXHIBIT 102-13, and with the side of this the spring connected with the diaphragm came in contact.

300 The insulating material on one side being removed so as to allow of metallic contact between the helix and the spring, the vibration of the diaphragm acted to cut in and out resistance according to the amplitude of movement thereof.

EDISON'S EXHIBIT INSTRUMENT 112-13 is similar to the instrument 102-13, only it is more perfectly constructed.

They did not work satisfactorily in comparison with the other instruments I had made wherein carbon was used.

EXHIBIT INSTRUMENT 121-13, Nov. 20, 1877,

corresponds to the device shown on the drawing exhibit 121-13.

In this case there was a piece of pencil lead in a groove upon which a spring rested connected with a diaphragm.

This was similar in its operation to the Exhibit 112-13 with the exception that the carbon took the place of the helix.

It is more fully carried out in my patent 235,013.

I here produce another instrument marked EDISON'S EXHIBIT INSTRUMENT 117-13, which identical instrument was made about the time of the sketch, Nov. 19, 1877, for more fully carrying out devices which I had before made, the diaphragm in the instrument being lost.

This instrument operated by varying the amount of contact on a disk of moistened paper, kept moistened by capillary attraction from a hard rubber chamber containing water, paper being immersed in it, feeding up after the manner of a wick.

If I remember right this instrument operated fairly for a water telephone.

EXHIBIT INSTRUMENT 140-13 corresponds with exhibit DRAWING 140-13, except the connection between the electrode and diaphragm consists of a solid ring in place of a rubber tube spring.

This instrument worked splendidly, and is the same as is now employed, although differently designed, that is, in a different shape.

I here produce an instrument marked "EXHIBIT WATER TELEPHONE INSTRUMENT."

I can't state exactly when this instrument was made, it might have been made in Dec, 1876, or any month between that time and November, 1876.

I here produce EXHIBIT INSTRUMENT 23-11, the same being only an arm between the extremities of which was fastened a piece of card-board coated with carbon, and placed in the electric circuit, and forced the diaphragm, the diaphragm forming the other electrode of the electric circuit.

Water Telephone

204 THOMAS A. EDISON.

cut. A screw served to bring the eardrum in contact with the surface of the diaphragm and give it an initial pressure.

This device differs from the transmitter in my application NO. 130 and EXHIBIT 28-11, as the diaphragm formed one of the electrodes.

The instrument shown in SKETCH 28-11 consists of a resonant chamber provided with a diaphragm; in front of the diaphragm is a pillar carrying an adjusting screw, upon the ends of which is a disk or arm, the surface of which is coated with carbon, the electric current passing from one side to the other through the carbon.

205 The surface of the carbon is in contact with the diaphragm; when the latter is vibrated more or less of the carbon is thrown in or out of the electric circuit to a certain extent, and the resistance of the circuit is varied in proportion to the amplitude of the sound waves acting upon the diaphragm.

This instrument was made March 21, 1877; if I remember right, it worked pretty good.

I here produce two diaphragms of iron, one marked "EDISON'S EXHIBIT IRON DIAPHRAGM" the other "EDISON'S EXHIBIT IRON DIAPHRAGM AND SPRING."

210 My impression is that the iron diaphragm and spring was made in April, 1877, the other one was made sometime in 1877, and practically used.

I here produce the instrument corresponding to the drawing EXHIBIT 36-13, the same having before been referred to by me in my previous testimony.

This instrument is marked "EDISON'S EXHIBIT INSTRUMENT 35-13, SEPT. 22, 1877."

The instrument, I think, was made within a day or two of the date of the sketch EXHIBIT 36-13, SEPT. 22, 1877.

This operated in practice first rate.

I here produce an instrument marked EDISON'S EXHIBIT INSTRUMENT WEIGHTED ELECTRODE.

*Iron
diaphragm*

THOMAS A. EDISON.

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I could not find the same in giving my testimony in the Chiswick Blake & Edison interference, 2 and 3.

The same acted to vary the pressure by inertia upon the carbon.

The spring carrying the carbon electrode opposite the diaphragm, and adjusted by a screw, as illustrated in DRAWING 181-11, was made about June 25, 1877, and corresponds to that portion of the EXHIBIT INSTRUMENT 181-11.

The instrument itself, 181-11, having been made before the DRAWING 181-11.

I here produce a tube with a small tube at the end, to which a flexible tube was attached, the same being marked "EDISON'S EXHIBIT A 3 TUBE."

215 This is the only remaining part that I know of that I have of three instruments which were constructed in December, 1873, and were to be duplicates of my EXHIBITS A AND A-1, but made in a first class, workmanlike manner, each tube of which was longer than the other in the three instruments. The tube which I now present is the sliding tube of the smallest instrument. These three instruments were made by a workman named James Egan, at my shop, 10 and 12 Ward street, Newark.

220 Each instrument was provided with an iron diaphragm, with a magnet in front of the same, as in my EXHIBITS A AND A-1, all of the magnets were included in the same circuit, and were used as telephonic receivers, and were capable of rendering audible sounds of any character.

Consent for Edison gives notice that the article in Mr. Prescott's Book, Chapter VI, page 218, and also the various patents granted to Mr. Edison, and to which reference has been made in his testimony are introduced herein as part of the record.

*Prescott
Book
chap 6 p 218*

310 THOMAS A. EDISON.

Adjourned to Friday, Nov. 12, 1889, at 10½ o'clock A. M.

S. I. G. *Notary.*

LABORATORY OF T. A. EDISON,
MEXICO PARK, NEW JERSEY,
Friday, Nov. 12, 1889.

Met pursuant to adjournment.
Same parties present:

Continuation of examination of Mr. T. A. Edison.

Q. 145. Please refer to the count in interference J., and your preliminary statement in that case, and state whether or not you have any explanation to make?

A. I find upon investigation that the instruments which I refer to in my preliminary statement interference J. were made in November, 1875, and not Dec. 20, 1875.

The receiving instruments made Dec. 20, 1875, were the same except that a strip of iron fastened across the mouth of the tube or resonant case was used instead of a complete diaphragm. The instruments having a complete diaphragm are my exhibits A and A', which were made in Nov. 1875.

The reason why the instruments were made with the top and bottom of the diaphragm cut off, was this: the instruments made in Nov. with complete diaphragms of iron reproduced the several muted sounds equally as well, and when it was desired to pick out any particular sound or series of waves, the column of air in the receiver was adjusted to respond to that series, but when adjusted at the best point, the re-inforcement was not very great, hence the instruments constructed Dec. 20th, with a strip, was to make the series desired more audible the width of the strip, bearing some relation in its vibrating times, to that of the particular series of waves which it was desired to render audible.

Q. 146. Please examine the first count of case F, and state whether or not the devices therein enumerated have

THOMAS A. EDISON.

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ever been used by you, and whether or not you claim to be the inventor of the subject matter of that count?

A. The instrument referred to in this count has been used by me; it is the instrument shown in my application case 145. It was used as a telephonic receiver, but it is capable of use as a telephonic transmitter, but I never used it as such. My Exhibit B, shows this device.

Q. 147. Please look at the count in interference D, and state the date when you made the special feature of the adjustable fluid holding tube?

A. It was either made in Dec. 1875, or between that time and Nov. 1876.

Cross examination by Wm. D. Hahlin, Esq., counsel for Mr. Gray. 314

xQ. 148. When did you commence operations under your agreement with Orton in 1875?

A. I think in July.

xQ. 149. Are you still working under that contract?

A. To a certain extent I am.

xQ. 150. Have the disbursements called for under that contract been made?

A. Disbursements were for a time made, when another contract was entered into, under which I am now paid.

xQ. 151. When was that new contract made?

A. It was made on the 22nd day of March, 1877. This was not for telephonic alone, but included all inventions. 316
It related to general telegraphic inventions.

(The contract is here produced, for examination of counsel, but witness does not desire to have it spread on the record.)

xQ. 152. Have you any contract relating specially to telephonic?

A. I have; it is dated May 31, 1878. I here produce it, and will furnish a copy of it, if called for.

Case 145

Ex B

Baldwin
X ex

Count J

Phil. state,

Count F

(The portions of the contracts desired by the respective counsel are extracted and made a part of the record, marked "Western Union Contract, March 22, 1877," and "Western Union Contract, May 31, 1878.")

xQ. 153. Had you in July, 1875, an experimental laboratory, and assistants to aid in developing your inventions?

A. Yes, sir; I had.

xQ. 155. How many assistants had you at that time?

A. I had three regular assistants, and several workmen.

317 xQ. 156. Please name such assistants and workmen, as far as you can recollect them?

A. James Adams, Charles Batchelor, Robert Spice were assistants. Of the workmen I remember John Krues, Chas. Wirth and James Egan.

xQ. 156. How long did James Adams act as your assistant?

A. He acted as my assistant up to the day he died in London. I cannot remember when he commenced to act as assistant in 1875, but he was assisting us in July, 1875, in conducting experiments on this subject. He was originally engaged as a night watchman. Mr. Adams

318 died in May, 1879.

xQ. 157. How long has Charles Batchelor been in your employment?

A. He has been in my employment for the last nine years.

xQ. 158. Please answer the same question as to Robert Spice?

A. Robert Spice was in my employment but a short time in 1875.

xQ. 159. What was the nature of the duties of your assistants?

A. Their duties were to assist me in conducting an ex-

periment, and in carrying out, by themselves, experiments of which general instructions had been given them by me.

xQ. 160. Did you enlarge your facilities for experiment and investigation when you moved from Newark to Menlo Park, in 1876?

A. Yes, sir.

xQ. 161. What has been your habit, as to keeping yourself advised of the state of the art, relating to inventions in which you are interested, and to the progress of scientific discoveries generally during the years 1875, 1876 and 1877.

A. My habit was to read a few of the ordinary scientific works, containing subject matter which I desired to understand, and to read the *Scientific American* and *American Journal of Science*, for current scientific literature.

xQ. 162. Please refer to your answer to question 13, and explain what appears to be a discrepancy in your reference to Fig. 6, of your Patent No. 263,013.

A. The principle shown in my instrument of 1875, was the increase and decrease of the resistance of a circuit by stretching and compressing, by means of a vibrating body set in motion by sound waves of a spiral spring, which of itself formed a resistance in a closed circuit containing a magnet; in Fig. 6 of my Patent 263,013, the same device is therein applied to vary the resistance of a closed circuit by expanding and compressing a spiral wire by a vibrating body, set in motion by sound waves, which in this case is a diaphragm.

xQ. 163. Please furnish, to be inserted in the record, a list of the applications filed by you between July, 1875, and Jan. 1, 1878; giving the dates of filing, the titles of invention, and the dates when patented; except, such pending application as you may deem it prejudicial to your interest to produce?

Month	Date of Appli- cation	Title	Date of Patent	No. of Patent
Jan.	16, 1873	Automatic Tel.	Sept. 24, 1873	164,823
"	"	Reg. index for Chess	Aug. 5, 1873	164,822
Jan.	16, 1873	Automatic Tel.	Aug. 5, 1873	164,823
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,321
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,322
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,323
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,324
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,325
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,326
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,327
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,328
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,329
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,330
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,331
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,332
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,333
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,334
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,335
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,336
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,337
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,338
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,339
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,340
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,341
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,342
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,343
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,344
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,345
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,346
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,347
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,348
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,349
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,350
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,351
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,352
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,353
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,354
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,355
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,356
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,357
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,358
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,359
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,360
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,361
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,362
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,363
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,364
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,365
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,366
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,367
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,368
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,369
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,370
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,371
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,372
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,373
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,374
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,375
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,376
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,377
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,378
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,379
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,380
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,381
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,382
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,383
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,384
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,385
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,386
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,387
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,388
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,389
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,390
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,391
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,392
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,393
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,394
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,395
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,396
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,397
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,398
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,399
Jan.	16, 1873	Electric Tel.	Nov. 18, 1873	165,400

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By J. J. STONOW, Esq.:

X. Q. 104. Please designate which of the applications stated in your last answer, and made in 1876, belong to the Western Union Company, in pursuance of the written and verbal contracts you have referred to?

A. Case No. 111 Duplex Telegraph, and case No. 113, Quadruplex Telegraph.

X. Q. 105. Please answer the same question as to 1870?

A. Cases No. 115, 116, 117, 118, 119, 122, 123, 124, 125.

X. Q. 106. Please answer the same question as to 1877?

A. Cases No. 126, 129, 135, 136, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148.

X. Q. 107. Please state how many Caveats you filed in 1875, in pursuance of said agreements?

A. Caveats No. 53, 56, 57, 58, 59, 60, 63, 66 and 71.

X. Q. 108. Please answer the same question as to 1876?

A. Caveat No. 72, 73, 74 and 75.

X. Q. 109. Please answer the same question as to 1877?

A. I find none in 1877.

X. Q. 170. State which is the first of those applications which in terms refers to the electrical transmission of articulate speech?

A. Case 130 is the first I think that refers directly in terms to electrical transmission of articulate speech, this case was executed April 18, 1877, and filed April 27, 1877.

X. Q. 171. State which is the first of said Caveats which in terms refers to the transmission of articulate speech?

A. I do not think I filed any caveat which in terms refers to the transmission of articulate speech in 1875 or 1876.

X. Q. 172. When did you first have any conversation with Mr. Orton, in relation to the electrical transmission of articulate speech?

A. I think in July, 1875.

X. Q. 173. What was the substance of your conversation with him on that subject?

A. The subject was a general one, relating to the transmission of sound.

X. Q. 174. Your Caveat 74, Fig. 4, shows and describes the receiver as being in closed secondary circuit of an

*Caveats
7 cases*

130 speech

*Orton
July 75*

Caveat 74

*Stonow
Cross X*

induction coil, whose primary consisted of many convolutions of fine wire, while the secondary consisted of a few convolutions of coarse wire, what was the object of winding the primary with many convolutions, and the secondary with few?

A. The object was so we could work over a longer resistance wire.

xQ. 175. Do you mean for the same reason that a sonometer intended for a long line, is wound with fine wire?

A. Yes, sir.

xQ. 176. In your 43d answer, you say that by the arrangement shown in said fig. 4: "The plate was set in vibration by positive and negative currents, and the sound desired was rendered audible." Please explain what you mean by the phrase, "the sound desired was rendered audible?"

A. The sound required to make up or convey intelligence was rendered audible by means of the vibration of the plate in front of the resonant chamber.

xQ. 177. Please look at your 18th answer. You have there stated the reason why you made the diaphragm referred to of different sizes. Why did you make the tubes of those three instruments of different sizes?

A. The reason why the tubes were made of different sizes, was because we thought it essential.

xQ. 178. In your application, No. 145, did the resonant tube or case, as shown in the drawing of the two figures, operate to re-inforce a particular sound, like those shown in your caveats 74 and 75?

A. The reel was tuned to pick out a particular note of vibration, but the chamber was not made to particularly re-inforce the particular sound given by the reel.

xQ. 179. Which of your caveats or sketches first shows a resonant tube or case in a receiver, which was not intended to particularly re-inforce a special pitch of sound?

A. I do not remember of having any sketch or of filing any caveat in 1875 which was not provided with a

chamber, when such chamber was used at all, that was not capable of re-inforcing some particular sound when used as a receiver. Neither do I remember of any such instrument in 1876. In fact, there is no telephone receiver which is not capable of re-inforcing some particular sound.

xQ. 180. My question asked about receivers not particularly intended to re-inforce a particular sound, in the sense in which you have just used those words in your 178th answer. Please answer my 179th question in that sense, if you have not already done so?

A. I have used a receiver in 1875, I think in December, in which no attempt was made to re-inforce any particular tone; I refer to Exhibit A. I will look at the sketches and caveats again.

xQ. 181. When did you first use a receiver consisting merely of a loose plate laid on a support over an electro magnet substantially like that shown in your application 144?

A. The precise thing is shown in two sketches, August 24, 1877, 110-12 and 114-15.

The instrument shown in these two sketches were made within a few days after the date of these exhibits.

In the instrument made the diaphragms were loosely held by pins merely to prevent their dropping off and being lost.

A loose diaphragm that is, a diaphragm free to expand and not secured rigidly at its edges, is shown in my EXHIBIT SKETCHES 101-11, dated June 30, 1877, it is the top figure on the sketch. Another one is shown in 100-11, June 27, 1877. These instruments were made within a day or two after making the sketch.

xQ. 182. In whose handwriting are the words "fig. 15, fig. 16" on the exhibit sketches for Caveat 75?

A. It is my handwriting.

xQ. 183. The figures so numbered on that sketch are the same as the figures which bear the same numbers in the caveat itself: are they not?

A. Yes, sir.

chamber to re-inforce sounds

loose disc

fig 77

caveat 75

*178
tubes*

xQ. 184. Is the middle drawing on that sketch which was crossed out, to be found in the caveat?

A. No, sir; it is not in the caveat.

xQ. 185. In your 29th answer you referred to some changes which would have to be made in the instrument shown in the drawing of your patent 141,773, in order to make an apparatus by which you could transmit articulate speech. In the apparatus fig. 1, shown in said patent, what was it that caused the motion of the electrode *f* in the cell?

A. The action of a current of electricity upon the magnet *e*, attracting the armature *d*.

xQ. 186. The variations in that current were due to the making and breaking of its circuit by the Morse key *a*, were they not?

A. Yes; when the instrument was not otherwise jarred.

xQ. 187. Does the specification describe any way of moving the electrode, except by opening and closing the local circuit by said key?

A. No, sir.

xQ. 188. In said apparatus what determined the extent of motion of the electrode?

A. When the lever *f* makes a full motion in either direction it is limited by the electrode *i* and the lock stop behind the electrode *e*.

xQ. 189. So that when it makes its full motion, it comes in contact with the electrode *i* at one end of its stroke and with the lock stop at the other end of its stroke; is that what you mean?

A. Yes, sir; when it makes its full motion,

xQ. 190. State whether or not this specification describes it as making its full motion when operated?

A. It does not say anything about making a full motion, xQ. 191. What is there except the electrode *i*, to limit the downward motion of the armature lever?

A. It might strike the magnet *e*, or the wire made by closing the key *a*, might be of such short duration that the armature lever *f* would be drawn downwards and

returned without coming in contact with the electrode *i*.

If the key *a* was operated very rapidly, and the tension of the spring *e* very great, the lever *f* might vibrate the electrode *i* without coming in contact with the electrode *i*. Whether it touched either limiting point would depend upon the number of breaks made in the cell containing the battery *b*.

xQ. 192. When operated as a telegraph operator would ordinarily operate it, in practically sending telegraph messages, would or would not the armature lever come down until it reached some stop?

A. It would.

xQ. 193. When did you first use in a telephone the uses of soft fibre, rubbed with plumbago or other equivalent, which I believe you have called "fluff"?

A. I think the date is August 7, 1877. See sketch exhibit 94-12.

xQ. 194. When did you first use a soft carbon button made of lampblack or other similar material?

A. I think I used a lampblack button in February or March, 1877. It was certainly earlier than March 25, 1877.

xQ. 195. Did you get any good result out of it then?

A. No, sir; it did not work at all; it was common lampblack.

xQ. 196. When did you first use lampblack buttons? A. I think it was about October 6, 1877. I think it was that carbon which was used in exhibit 18-13. It is also mentioned in the complete specification of my British patent No. 2009, sworn to the 24th day of December, 1877. It is barely possible that I did not use the specially prepared lampblack until November or December, 1877.

xQ. 197. Please explain the arrangement and operation of your exhibit 9-2.

A. The instrument was a local instrument, entirely disconnected from the line, and received its vibrations

*spring limits
motion*

*soft fibre
chey 7.77*

*soft carbon
Dec. 1877*

*Octo 77.
buttons of carbon
in Eng pat*

141,777

*key shown
& closed*

through the air from an instrument mounted on a resonant box placed in close proximity thereto. The apparatus on this second box was connected with this main line. The second box and the box shown in exhibit 9-P, as well as the vibrating bellows thereon, consisting of tuning forks, were in unison with each other acoustically. The two resonant boxes had their mouths placed opposite or near to each other.

sq. 198. Please look at your sketch of Oct. 12, 1876, and tell me whether or not it embodies the principle of cutting out more or less of film, spoken of in your 27 answer?

A. Yes, sir. I believe it does.

sq. 199. What was the essential part of that electrode the oil stone, or the plumbago had conductor?

A. It was necessary that there should be some insulating body coated with plumbago, the plumbago film was the essential thing.

sq. 200. When did you first hear of Mr. A. G. Bell?

A. I think it was about November or December, 1875.

sq. 201. How did you first hear of him then?

A. Some one told me that such a man was working in the same line as Gray on harmonic telegraphy.

sq. 202. When did you first hear of his exhibition of his speaking telephone at the Centennial?

A. Something in July, 1876. I think it was E. H. Johnson who first told me. From the description given me by Mr. Johnson that by talking against a diaphragm in front of a magnet to generate induction currents I was led to believe what he said. I did not think it possible that induction currents could be generated sufficiently strong by this means to transmit practically articulated speech. I want to say here, that I never conceived the possibility of transmitting articulated speech by talking against a diaphragm in front of an electro-magnet. I had never used my exhibits A A' for talking with, but only for receiving.

sq. 203. Why did you not give Mr. Bell credit for

that in Mr. Prescott's book at the same time when you said you had not invented that principle, if you then thought he was entitled to the credit of it?

A. I did most emphatically give Mr. Bell the credit of the discovery of the transmission of articulated speech by that principle in this article, but it was scratched out by some person unknown to me after it had been delivered to Mr. Prescott, and it was not published.

sq. 204. Was Mr. Prescott at the time that book was published an officer or employed by the Western Union Telegraph Co. or the Gold and Stock Telegraph Co. or the American Speaking Telephone Co?

A. He was employed I knew by the Western Union Telegraph Co., and he was I think a director in the American Speaking Telephone Co.

sq. 205. Who furnished the drawing and the information which appeared under the head of Edison's Pressure Relay in the Journal of the Telegraph for June 1, 1877?

A. I furnished the information and exhibited the instrument at work to Mr. Prescott, Mr. Orton and others a little while before the appearance of the article. This exhibition took place at the office of the Western Union Telegraph Co. at New York.

sq. 206. Mr. Prescott was at that time electrician of the Western Union Co., was he not?

A. Yes.

sq. 207. The Journal of the Telegraph was published at the office of the Western Union Telegraph Co., was it not?

A. Yes.

sq. 208. When did you first have any talk with Mr. Orton about the telephones of Mr. Bell, or of the Bell Telephone Co.?

A. That would be very difficult for me to remember when I first talked to him on the subject.

sq. 209. Did you talk with him much on the subject?

A. No, sir; not a great deal.

sq. 210. You said in one of your answers that you

*Give credit
for transmitting
speech by
magneto*

Ex 9.-9

*cut out
film*

oil stone

Bell

Gray,

Bell

frequently talked with him about your speaking telephones. Can you tell me when you began to talk with him about them?

A. I think in July, 1875; I first talked with him on the subject of transmitting articulations.

xQ. 211. My question was intended to ask you when you first talked with him about speaking telephones which you had made?

A. If you mean transmitters, I think it was in March or April, 1876.

xQ. 212. Which of your agreements with the Western Union first refers in terms or in so many words to the transmission of articulate speech by means of electricity?

A. When they bought out my interest in speaking telephones by the contract of May 31st, 1878, which inventions were made under the contract of December 14, 1875.

xQ. 213. In your apparatus shown in patent 141,777, please tell me whether any skilled electrician or telegrapher would practically construct or expect to work the instrument Fig. 1 without some stop to prevent the armature coming in contact with the core of the electro-magnet?

A. Yes, it would be an easy matter to use a hollow helix with a core attracted inwardly, axially so that magnetic attraction would cease at a centre point.

348 If such an axial magnet were used it would be unnecessary to have any downwardly acting stop.

Adjourned to Saturday, Nov. 13, 1880, at 10½ o'clock A. M.

S. L. G.

Notary.

Laboratory of T. A. Edison,

Mexico Pass, N. J., Nov. 13, 1880.

Met pursuant to adjournment; same parties present, and Mr. F. H. Betts, counsel for Irwin and Volkens.

xQ. 214. My question related solely to the apparatus

shown in patent 141,777, the drawing and description in that patent do not show an axial or sucking magnet, do they?

A. No; the instrument in that patent is provided with an ordinary magnet.

xQ. 215. In the apparatus shown in Fig. 1 of said patent would any ordinary constructor of electrical instruments, or any ordinary telegraph operator, practically construct or expect to work the instrument Fig. 1 without some stop to prevent the armature coming in contact with the electro-magnet?

A. That would depend upon what use he was going to put the instrument-to. The apparatus is for the transmission of undulatory currents in a closed circuit without breaking the same. It can be applied to many uses, if employed in a telephone the limiting stop *z* would still be used.

xQ. 216. Please to look at your patent 182,996, dated Oct. 10th, 1876, application filed May 16, 1876, and tell me whether when it is in practical use the vibrations of the reed *u* will or will not always have the same amplitude?

A. No, sir; they do not have the same amplitude, they constantly vary in their amplitude.

xQ. 217. Why?

A. For the reason that when a series of vibrations proceed from the transmitting station over the line to form a dash the first few waves give it an excessively small amplitude and each succeeding wave increases that amplitude up to a point where the amplitude will become constant after the waves have ceased coming over the line the fork decreases its amplitude down to zero gradually.

xQ. 218. Please answer the same question as to the reed *v*?

A. The reed *v* will make various amplitudes of vibrations according to the strength of the battery. If there is a strong battery it may make vibrations of a quarter of an inch and as the battery weakens the length of oscillation will decrease, but the reed will still perform all

350 *undulatory currents*

pat 182,996.
and varies in amplitude

351

its functions even if it does not make more than an exceedingly small fraction of the greatest amplitude.

Counsel for Bell & Blake gives notice that he shall refer to Patents of Edison 283,016 and 198,087 which have not yet been put in.

It is understood that all patents and printed papers and books referred to in this examination shall be considered as put in evidence in accordance with the stipulation at the end of answer 2.

353

By COL. GEORGE W. DYER:

x(219. When did you first produce a telephone transmitter intended for and capable of transmitting oral conversations and sounds telegraphically by increasing and decreasing the strength of the electric currents so as to produce electrical waves or vibrations for exact reproduction at the receiving station.

A. In December, 1875.

x(220. Point out the instrument please!

A. I have already testified as to an instrument marked water telephone in which I stated that I did not remember whether the instrument was made in December, 1875, or some time in 1876, we made so many of this class of transmitters in 1876 that I cannot be sure that this is the one made in 1875.

x(221. When did you first produce a transmitting telephone having the spring forming or carrying one electrode and constantly pressing against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm?

A. I think about November, 1875, I used a spring forming and carrying one electrode and constantly pressing against the other electrode, this is shown in Exhibit 8-9, but it was not a speaking telephone, but a musical

telephone, the diaphragm being substituted for a tuning-fork. I have here an Exhibit which is 17-9, which consists of a telephone provided with a diaphragm and two electrodes constantly pressing against another electrode and operated by a movement of a diaphragm—this was also a musical telephone.

Answer objected to as not in conformity with the preliminary statement.

xQ. 222. When did you first produce a telephone adapted to transmit articulate speech having the spring forming or carrying one electrode and constantly pressing against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm?

A. In Sept. or Oct. 1876 these devices are shown in my Exhibit 102-10 the electrodes in this case press upon the diaphragm indirectly through another spring. The first practical introduction of this device was on the lines of the Western Union Telegraph Co., March 25, 1877.

The same objection made as to the preceding answer.

xQ. 223. Have you any instrument made in accordance with Exhibit 102-10?

A. No, Sir. I have no instrument made exactly as in Exhibit 102-10, these devices were afterwards worked up in 1877, and are shown in my patent 283,013, figure 3. In this connection I will state that when I rest on my preliminary statement in the case of Blake & Chinnock, I supposed that carbon points were in question, hence I did not refer to those earlier devices where only platinum points were used.

The same objection made as to the preceding answer.

356

case 8.
spring carrying
electrode.

102-10,

357

See 1875
articulating
Telephone

Water
Telephone

case 1
Spring electrode
Nov. 75

8-9

358 THOMAS A. EDISON.

xQ. 224. What do you mean by the expression "worked up" in your last answer?

A. I refer to being worked up and put in better shape.

xQ. 225. What instrument was employed on the lines of the Western Union Telegraph Company, March 25, 1877, referred to in answer 222.

A. The instrument on the lower part of the sketch 20-11. The instrument on the top of such exhibit being shown in my patent 293,014.

xQ. 226. Have you an instrument made in accordance with sketch 20-11?

359 A. No, sir. I have no exhibit of the instrument made at that time from the lower sketch, but think there is a model in the Patent Office, filed with application upon which patent 293,014 issued, but do not know whether that model is a working model or a dummy.

xQ. 227. When did you first produce a telephone adapted to transmit articulate speech, having the spring forming or carrying one electrode and constantly pressing directly against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes and yield to the movement of the diaphragm?

A. I think I first produced an instrument intended to transmit articulate speech, having a spring forming or carrying one electrode, and constantly pressing directly against the other and the diaphragm, in September or October, 1875. I have no sketch or exhibit of instrument made at that time, but perhaps the fig. 12 in my patent of January 14, 1876, may have some bearing on the case in the case.

(The same objection made as to answer No. 221. Also as to the statement as to what the witness thinks.)

xQ. 228. Please point out the first sketch, exhibit or instrument which you have got, made subsequent to September or October, 1876, and which embodies the features called for in 227th question.

Count 1

Exp. 1876

Fig 12
Count Jan 14
1876

THOMAS A. EDISON. 361

A. I have a sketch marked 38-10, in which the mechanical equivalent of a spring in this case is applied therein, the initial pressure between the electrodes being obtained by attraction of gravitation, the difference between an instrument of this character having a lever and one having a spring, would be that the latter might, if properly constructed, be placed in any position, whereas, if gravitation was used to produce the initial pressure between the electrodes, it must be placed in one particular position. I do not wish it to be inferred that because I have no exhibit that I did not use spring electrodes even before this date, which would meet the count in case 1. My impression is that I did have such electrodes previous to July 20, 1876. In September and October, I remember distinctly I employed several electrodes, consisting of springs one behind the other, the pressure between such springs being obtained by adjusting them toward the diaphragm. The exhibit 102-10 shows a plan of a device to amplify the motions of the electrodes by levers instead of working them directly upon the diaphragm.

Count 1.
spring

(The same objection is made as to answer No. 224; also that the answer is not responsive to the question.)

xQ. 229. Question repeated.

A. That question has been fully answered, except that, as I have stated, the levers are the mechanical equivalents of a spring in all respects in their applications for this purpose, the initial pressure being capable of being varied by gravitation and the movement of the instrument.

xQ. 230. Are you unable to point out any sketch, exhibit or instrument made subsequent to September or October, 1876, embodying the features called for in the 227th question?

A. The Exhibit 38-10 embodies all the features con-

tained in that question, as far as the working of the instrument is concerned.

xQ. 231. The Exhibit 58-10 is dated in July, 1876, and the question calls for sketches, exhibits or instruments subsequent to September or October, 1876. Please now answer the 227th question?

A. I misunderstood your question. I have here a sketch, marked Exhibit 10-11, dated February 11, 1877. I have also here a part of the instrument "Edison's Exhibit Instrument 10-11," made substantially like Exhibit 10-11. I have also an Exhibit 100-11, and "Edison's Exhibit Instrument 100-11." The sketch 100-11 is dated May 25, 1877. The instrument shown in Exhibit 100-11 was embodied in an application for a patent, and filed July 20, 1877, in case No. 141.

xQ. 232. State the composition of the electrodes shown in sketches and exhibits of portions of instruments, and in said application for patent?

A. The electrodes in Instrument Exhibit 10-11 are of platinum upon the end of watch-springs—that is to say, the electrodes are formed of watch-springs tipped with platinum. The Instrument Exhibit 100-11 is a brass spring provided with a cup, which originally held a small cylinder of carbon.

Cross-examination suspended until December 3d, 1880. The time for taking testimony of the various parties is to be enlarged as may be required in consequence of this suspension.

S. L. GRIFFIN,
Nodary.

(NOTE.—December 3d, 1880. By consent of the various parties an adjournment is taken until December 9th, 1880.)

S. L. G.,
Nodary.

EDISON'S LABORATORY,
Menlo Park, N. J.,
December 9, 1880.

Met pursuant to adjournment.

Present.—L. W. Serrell, Esq., Counsel for Mr. Edison; W. H. Baldwin, Esq., Counsel for E. Gray; Col. George W. Dyer and Mr. Betts, of Messrs. Betts, Atterbury & Betts, on behalf of Messrs. Irwin, Voecker & Richmond; and J. J. Storrow, Esq., on behalf of Messrs. Bell & Blake.

The Cross-examination of Thomas A. Edison is continued.

By Mr. Herres.

233 xQ. In several answers you have spoken of the Edison telephone transmitter, as described in Present's work on the speaking telephone, and in the article sent you by Mr. Orton. Please state precisely what was the mechanical difficulty with the Edison instruments, as they are described, which in your opinion rendered them unsuited for transmitting articulate speech?

A. The first difficulty is that there is no means whereby the strength of the electric current can be varied to allow of the translation of sound waves into electric waves of corresponding pitch and quality. Another difficulty is the rebound of the electrodes on each other both by the effect of the vibrations due to sound, and by the effect of wind rushes in the act of speaking.

234 xQ. Is the rebound of the electrodes the cause of the first difficulty mentioned therein?

A: No, sir.

Young after
Octo 76
case 141.

Electrodes

Ris not
a
speaker

233 xQ. What is the mechanical cause of the first difficulty?

A. As I have stated there is no means provided to increase or diminish the strength of the current between the electrodes sufficient to make it a practical telephone for the transmission of articulate speech, or a telephone which could be called in any sense a practical telephone.

236 xQ. Can you not answer the question more specifically?

A. I will if you will state it more specifically.

237 xQ. What specific addition or modification of the Reis instrument, as described in those publications, is necessary to adapt it to transmit articulate speech?

A. I have found that carbon placed between the electrodes makes it a very good transmitter.

238 xQ. If one of the electrodes of the Reis transmitter as described in those publications was made of carbon, would it then be adapted to the transmission of articulate speech?

A. Yes, sir.

29 xQ. Suppose the electrodes of the Reis transmitter were made of iron instead of platinum, as described in such publication. Would the transmitter then be adapted to transmit articulate speech?

A. Perhaps something could be transmitted on such an instrument with iron electrodes, providing the surface of the iron was presto oxydized it would be rather a poor affair as a transmitter of articulate speech.

340 xQ. Why would it transmit articulate speech at all, if iron electrodes were used instead of platinum?

A. Because the surface being proto-oxide of iron, is a material of high resistance, and being generally rough would present a number of points which might allow, under certain conditions as to adjustment, a word now and then being transmitted, but I think that if any words were transmitted it would have to be done one way in the present state of the art, when we know so much about telephones.

*no change
of strength
of current*

*Reis and
carbon a
good trans -*

241 xQ. Suppose one of the electrodes of the Reis transmitters, as described in said publication were made of iron, and the other of platinum, would the transmitter be adapted to transmit articulate speech?

A. If you mean adapted as a regular transmitter, I say no; but if you mean could two experts in the present state of the art transmit a word now and then, then, then I say yes.

242 xQ. Have you ever tried the Reis transmitter with iron electrodes?

A. Yes, sir.

243 xQ. When?

A. I think about July 1876.

244 xQ. Did you succeed in transmitting any words with it at that time?

A. I can't say; we generally knew what was coming, and knowing what was coming even a Reis transmitter, pure and simple, transmits and reproduces sounds which sound almost like that which was being transmitted, but when it was attempted to transmit something which the receiver did not know, it was very seldom that any word was recognized.

245 xQ. Like which drawing in Prescott's work describing the Reis transmitter was the one which you tried with iron electrodes, about July, 1876?

A. It was similar to that shown on page 13.

246 xQ. Have you got that instrument, or one like it, now?

A. It was not made exactly like that drawing, it was a tube with a diaphragm; we made a great number of kinds about that time; I don't know whether I have got the instrument or not, or whether some of my exhibitors already presented in this case have not got some of the parts used at that time; I would not be liable to preserve an instrument that did not work satisfactory.

247 xQ. In your answers to the 238d question, you spoke of a difficulty in the Reis transmitter due to the rebound of the electrodes; does that difficulty occur be-

*Reis
July 76*

*Reis will
work but
not for
business*

cause of the smooth character of the contact surface between platinum electrodes?

A. No, sir; that is not the cause of it.

2188Q. What is the cause of it?

A. It is caused, as I have stated, by sudden vibrations and by the action of wind rushes which accompanies talking.

2193Q. Is it because of the smooth character of platinum electrodes that sudden vibrations or wind rushes causes this rebound to a degree to prevent the instrument from transmitting articulate speech?

A. No, sir; it is due to momentum, for instance, if you pivot a drum stick at the periphery of a drum and allow the extremity to rest upon the centre of the drum, and a tap is given on the bottom of the drum, the drumstick will not follow the motions of the membrane, but there will be several rebounds of the drumstick.

2200Q. Why is that?

A. It would take me several hours to study out the complex action so as to enable me to describe it properly.

2218Q. Please describe it as well as you can now with out studying the matter up?

A. Because the drumstick is free to follow its own motions.

2223Q. Why does the insertion or substitution of carbon for one of the electrodes of the Edison transmitter make it a very good transmitter, as stated by you above?

A. Because the carbon is so arranged that either there can be no motion or scarcely any given to the diaphragm or else the effect of the rebound of the electrode is rendered nugatory. The fact of the use of carbon allows of a great pressure to be placed between the two electrodes sufficient to reduce the effects of momentum to a minimum and at the same time to allow of the transmission of articulate speech, were sufficient pressure put upon the electrodes of a Edison transmitter to prevent rebound of the electrodes when the instrument is being set in motion, by ordinary voice the difference of elec-

tro motive force between the points would be so infinitesimally small that I doubt that in the present state of the art with the most delicate receivers even musical sounds could be transmitted and reproduced audibly. The use of carbon allows of great pressure being placed on the electrodes, reducing the tendency of the neutralization of signals by rebound of electrodes, and at the same time does not prevent the transmission of articulate speech.

30Q251. You have spoken in your direct evidence of a number of apparatuses used as telephone transmitters, some of them you have spoken of as as "unsatisfactory" others you have spoken of as "practical," or "not practical for business purposes." Was't you explain fully what you mean by these several phrases?

A. I was under contract with the Western Union Telegraph Co. to devise a telephone system for public use. When I tried an instrument and I did not think either the Western Union would be satisfied for the public, I called it unsatisfactory. When I obtained an instrument that would work so as to produce any degree of satisfaction when used by the public in the absence of anything better I called that practical.

30Q251. Do you regard any instrument which is not so perfect as to be capable of producing satisfaction on the part of the public in the absence of anything better, as the complete embodiment of an invention?

A. Anything that the public can work and will pay for I consider practical.

30Q252. Do you consider any perfection of the telephone less than that, a complete embodiment of the invention?

A. I do not consider an invention has been made until the apparatus works to the satisfaction of some one other than the inventor, that is to say until the object of the invention is attained with some degree of success.

rebound

Momentum

Carbon and pressure

*Terms
satisfactory
unsatisfactory
Practical*

Practical

Invention

256xQ. Please illustrate what you mean? When did you first attain the object of transmitting articulate speech with that degree of success which entitled you to consider yourself as having made that invention?

A. I think I conceived the invention in 1874. I made drawings of it in 1875. I reduced it to practice in December, 1875, but it did not work satisfactorily because it was not loud enough.

257xQ. When did you reduce that invention to practice with that degree of success which entitled you to consider yourself as having made it in a practical form?

A. It was in a practical form in December, 1875. We did not make it work owing to peculiar conditions, the reason why I know it was practical at that time is that since the present state of the art has been attained we have made instruments of that kind which worked satisfactorily as regards articulate speech, but not satisfactory as to the volume of sound.

258xQ. When first did you ever produce a telephone transmitter which worked to the satisfaction of some one besides yourself in transmitting articulate speech?

A. If you mean satisfactory in the sense that it would fulfil my contract with the Western Union that it would give them a practical telephone I should say about February or March, 1877. As for the water telephone I do not think even now it would be satisfactory to the public. If you refer to a registering telephone then I had that complete in 1875.

259xQ. I mean "satisfactory" in the sense in which you used the word "satisfaction" in answering the 254th question. Please answer the 258th question on that understanding?

A. I think in June or July, 1876, we had a telephone which transmitted articulate speech very good. It was satisfactory as far as it went as a telephone transmitter but was not satisfactory as an instrument to give the Western Union a practical working telephone.

Telephone
Conceived 1874
made practical
(1875)
not loud enough

Satisfactory to
W. U.
March 1877
June 1875

June 76
good articulator

259xQ. Which instrument was that; point out the Exhibit or sketch which illustrates it?

A. The sketch marked Exhibit 3-10 illustrates one of experiments tried in 1876.

260xQ. Is that the one you referred to in your 259th answer?

A. That is the only sketch I can find of the instrument I referred to.

261xQ. Have you any instruments corresponding with that sketch?

A. Not exactly corresponding to that instrument. I have an exhibit called Water Telephone, which is analogous to this.

262xQ. Is the Exhibit Water Telephone the nearest thing you have to instrument shown in Exhibit 3-10?

A. Yes, sir.

263xQ. Is a skin or animal membrane diaphragm capable of use successfully in telephone instruments required for ordinary business purposes?

A. No, sir, not as ordinarily arranged; of course they would work after a fashion.

264xQ. Have you ever known or heard of one that was so arranged as to be capable of use successfully for ordinary business purposes?

A. Yes, sir, I have, but it is not so practical as a metallic diaphragm, as it is more liable to get out of adjustment, as I have seen it arranged. I do not here refer to a string telephone.

265xQ. When and where did you ever see or hear of this?

A. As far as a diaphragm alone is concerned, made of animal membrane, I used it in 1875. I used it at various times in 1876, but if you refer to its connection with other instruments, to make a transmitting telephone for public use, then I think the combination was made by myself in February or March, 1877.

267xQ. Point out the sketch or exhibit which illustrates the telephone spoken of by you, as made in February or March, 1877.

Ex. 3-10.
made Aug 76

Murham
1875
comb.
March 77

A. I think the Exhibit 8-11 illustrates that.
288 Q. What is the peculiarity of the arrangement of the skin or parchment diaphragm, shown in Exhibit 8-11, which renders it capable of use successfully as a telephone diaphragm for ordinary business purposes?

A. I think there were means provided, whereby the diaphragm could be kept in a state of tension. This instrument was afterwards changed, and embodied in Case 119, a metal diaphragm being substituted. In paragraph 5 of that application, the following occurs: "The diaphragms c, d , are applied at the side or end of their respective boxes, and these should be provided with tightening-screws g , connected on the plan of a bottle-head, so that the diaphragm may be of the proper tension. I prefer, and generally use, sheet metal for these diaphragms, which may be of a suitable thickness, say one-eighth of an inch, more or less, according to the size of the instrument." In the sketch 8-11, the top figure, on the left-hand side illustrates a means of adjusting the tension of the diaphragm, as I have stated. Parchment diaphragms have been used by me in 1873-76, but not in such a way as to meet the requirements of your question.

290 Q. Did you ever use the instrument shown on Exhibit 8-11, with a parchment diaphragm, for any business purposes?
A. I used it on a telegraph wire and transmitted and reproduced articulate speech with such a degree of success that it was capable of use for business purposes, but I did not permit it to be used for business purposes—that is to say, that particular instrument.

270 Q. Is a stretched membrane diaphragm capable of use successfully for business purposes without means being provided for adjusting its tension and thereby keeping it in a state of tension?
A. That will depend on the character for means for increasing and decreasing the strength of the current.

371 Q. Please explain yourself more fully:

A. If the means employed for varying the resistance of the circuit are such as to allow of the transmission of articulate speech when great pressure is placed upon the parchment diaphragm, then this pressure keeps the diaphragm in its state of tension and the instrument would operate, or if, on the other hand, but light pressure could be placed upon the diaphragm, and the device used were for transmitting articulate speech was not very sensitive, and it was necessary to talk loud, then the moisture of the breath would cause a warping of the diaphragm and throw the instrument out of adjustment. Again, if the tension regulator was very sensitive, the person could stand off a great distance, so as to prevent the moisture of the breath from coming in contact with the diaphragm. If a Reiss transmitter was used with a parchment diaphragm, and no means were provided for keeping the diaphragm in a state of tension, it would soon buckle up by the effects of moisture and throw the instrument out of adjustment when provided with a rigid point, or transmit a great many extra sounds not desired when a flexible spring contact electrode was used; besides, when buckled and flabby, the wind rushes would tend to throw the electrode out of adjustment.

By Mr. SHERELL:

272 Re-D. Q. You speak, in an answer to cross-examining 228, of an instrument similar to the Reiss transmitter, with one of the electrodes of carbon; state whether or not the Reiss transmitter would be adapted to the practical transmission of articulate speech if the electrode was lying loosely against the diaphragm and liable to receive a movement from the diaphragm that

*parchment
& adjustment
for tension*

*Reiss loose
electrode*

*Carbon 8-11
(Case 130)*

Ex. 77

*capable of
use for
business*

might cause a rebound, as in the instruments illustrated in the Speaking Telephone by Mr. Prescott?

Objected to by counsel for Irwin & Voulker as involving an assumption opposed to fact.

A. I do not think it would be a practical instrument if no means were taken to prevent or reduce to a considerable extent the rebound of the electrodes, but then if carbon were used as an electrode it would not be a Reiss transmitter.

395 273 R-D-Q. You speak of considering an invention complete when it is in a form adapted to public use. State whether or not in your efforts to produce a telephone instrument, you lessened or suspended your efforts at any time when you had obtained an instrument capable of producing articulate speech, but which might have been discovered as liable to become injured when handled in the ordinary manner by the public.

Objected to as leading.

A. I never lessened my efforts to make a telephone which would be practical in the hands of the public from 1875 up to 1878. It must be remembered that it was Wm. Orton who decided whether an instrument was practical or not. I submitted several instruments to him which I thought were practical, but which he decided were not, and I knew that much worse instruments than I presented to Mr. Orton are working to-day, and people are paying for the use of them now.

396 274 R-D-Q. In connection with your testimony you have spoken in some instances of your experiments. Will you please define your understanding of that word, so far as you have used the same?

A. I should say that an experiment was an effort to accomplish a certain object; if the object was not accom-

plished, the experiment was a failure, but if the object was accomplished, the experiment was a success.

275 R-D-Q. In connection with your telephone, what was the object sought by you to be accomplished?

A. The production of a speaking telephone, capable of practical use—one that the public would pay the Western Union for, and one the Western Union would pay me for.

276 R-D-Q. Referring, then, to your answer to redirect question 274, are we to understand that you use the term experiment in the sense referred to in your last answer?

Objected to as leading.

A. Yes, sir.

277 R-D-Q. In answer to cross-interrogatory 260 and 261 you speak of the movement of a drum-stick when free to follow its own motions. State what you refer to as the device giving motion to the drum-stick?

A. I have already stated that it was the diaphragm or drum head.

The witness states that Mr. Prescott's book on the Telephone was published before August, 1878, and he thinks in July, 1878.

THOS. A. EDISON.

Instruments submitted to Orton

Experiment

LABORATORY OF THOMAS A. EDISON,
 MENLO PARK, NEW JERSEY,
Friday, Nov. 12th, 1880. }

CHARLES HATCHER, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., counsel for Mr. Edison, as follows:

1. Q. Please state name, age, residence and occupation?

A. My name is Charles Hatcher, age 35, residence Monte Park, N. J.; assistant to Thomas A. Edison.

2. Q. How long have you been employed by him?

A. Since 1876.

3. Q. State what has been the practice in Mr. Edison's establishments in regard to making, dating and witnessing sketches and drawings?

A. The drawings were generally made at about the same time that they are dated and signed; sometimes these drawings were made a day or two before showing to his assistants, but were dated and witnessed by his assistants generally immediately after their explanation; the drawings were generally accompanied by an order to make the instruments or experiments illustrated. As far as I know the drawings were never ante-dated. If a drawing had no date it was left without, or the date of its finishing put on it.

4. Q. About what time did Mr. Edison commence to construct any instrument adapted to transmit sound waves electrically?

A. About the end of July, 1878.

5. Q. What, if any information, was possessed by you and Mr. Edison previous to the time of commencing to experiment, which showed what others had done in this general line?

A. I do not know in regard to what Mr. Edison knew and I had little information on the subject, but what I had read or heard of the Kelo's telephone.

6. Q. What time in the year 1875 was it when you obtained a knowledge of the Kelo's telephone?

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A. I think about July, 1875; my attention was called to it by Mr. Edison.

7 Q. What, if anything, did he show you?

A. I think he spoke at that time of an article written by Vandergriff on this telephone, and soon after showed me a translation of an article which had been furnished him by the Western Union Telegraph Company on the same telephone.

8 Q. State whether or not that article on the "Reis's" telephone is here present?

A. It is.

9 Q. Upon the said translation there is a sketch in pencil of which EXHIBIT TRANSLATION BY W. U. TRANSLATOR OF REIS'S TELEPHONE is a photo lithograph. Please state when you first saw that pencil sketch.

A. I cannot tell exactly when I first saw it. I believe the sketches were put on within a month after receiving the paper, but they may have been there when I first read the paper. I believe I saw it on there as early as August or Sept., 1875.

10 Q. Did you at that time receive any explanation of what that sketch showed, and if so what was said?

A. I did not at any time receive an explanation of the drawings that I remember or I think my name would have been on them; they, however, were understood by me when I first saw them, because we were working on instruments having that general principle.

11 Q. Did you know of the Helmholtz resonators previous to the time of seeing these sketches?

A. Yes, sir; Mr. Edison had borrowed, I believe, from some one tuning forks and resonators to experiment with; these were known as Helmholtz resonators and forks; one of the contact points in this instrument passed into a cup of mercury which was made adjustable vertically to suit the vibration of the fork.

12 Q. From your knowledge on this subject aided by the sketch, and from what you were doing in August or September, 1875, what did you understand the sketch

*Helmholtz
resonance
adjustable*

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EXHIBIT "TRANSLATION REIS'S TELEPHONE" to show?

A. The top figure represented a chamber with a diaphragm or membrane on the lower end of it connected one prong of a tuning fork, the other prong of the fork having a point extending down into a cup of mercury, the idea being to transmit sound waves from the diaphragm into the mercury which does not show itself in a circuit, but I judge that was what was intended. The middle figure shows a diaphragm similar to Reis's telephone, to which was fastened one end of a lever, the other end of which dipped into a glass of water and formed one electrode of a circuit; the other electrode being placed directly under the first. This circuit included a battery and a magnet. The third figure represents a resonant chamber with a diaphragm on its end, to which was fastened a small piece of metal in the shape of a knife edge; directly opposite and adjustable towards it was a similar knife edge of metal, above which a funnel was placed, so that water or other liquids could drop and stay by capillary attraction between the two knife-edges; these two knife-edges, I also supposed, were intended to be included in an electric circuit also, with battery and sounder. I do not know of these instruments being made as early as the date I speak of; similar instruments were made after that date.

13 Q. I here produce the mass of exhibits that have been put in this case by Mr. Edison in giving his testimony; upon many of them the name of Charles Batchelor is written, state, if you know, who wrote that name and for what purpose; and state also whether or not the exhibits have been frequently seen by you since the respective dates that they bear; and state also whether or not these exhibits have been changed in any essential particular since they were made?

A. I wrote my name on them as a witness that the drawings were made at the time the respective dates were put upon them. Most of the exhibits have been seen by me frequently since they were made, and I do

*Explains
sketch on
Reis's trans*

not believe they have been altered since they were made except the notary's marks, and a few dirt marks and oil marks on them. Tracings of many of these drawings have been made, and this may be the cause of the ink dots and marks I see upon them. These dots and dirt marks do not change the character of the exhibit. I will now go through these carefully, and if I notice any thing contrary to what I have said I will mention it. I identify the following exhibits made in 1875: 4-3, 7-3, 8-3, 9-3; 10-3 two exhibits; 22-3 two exhibits.

14. Please describe generally the devices shown on the list enumerated exhibits?

677 A. In EXHIBIT 6-3 is shown a resonant case on which is secured a tuning-fork; there is also placed on this case a battery, marked X, the terminals of which are in a battery liquid. The outside circuit includes a sonometer. The battery is marked x, which refers to some writing on the exhibit which explains that the battery is a quickly polarizing battery, and the vibrations of a tuning fork tend to depolarize the plates, thus making more or less resistance in the circuit, according to the vibrations of a resonant case. This was entirely a closed circuit, and the electro magnet in that circuit responded to the rise and fall of current. My name is not upon this paper, but the date and words "Acoustic Telegraphy" were written by me upon Nov. 16, 1875. The instrument was made and it worked, but with what degree of success I do not remember. EXHIBIT 7-3 illustrates a spiral iron wire held between two adjustable terminals, around which is held a spool of wire. The idea of this sketch was to make an instrument which would alter the resistance of a closed circuit by contracting the spiral iron wire by magnetism generated from the helix. The exhibit was made Nov. 16, 1875. I signed my name at that date. This instrument illustrated by that exhibit was also made, and did, as far as I remember, what was required of it, namely: to increase or decrease the resistance of a closed circuit, of which the spiral iron wire was a part, and in which circuit was also included a sound-

er. EXHIBIT 8-3 illustrates a resonant case, on which is mounted a tuning fork, also a magnet acting on one prong of the tuning fork, also a contact spring and adjustment for making and breaking contact with a point on one prong of the fork. When the magnet attracted one prong of the fork that held the point of contact, it broke the contact between the spring and the point on the fork, allowing the fork to resume its natural position in consequence of the circuit through the spool being opened; as the fork resumed its natural position it made contact again with the spring which in turn closed the circuit through the spools. This was repeated as often as the vibrating time of the fork would allow of.

15 Q. Please state in that connection, whether or not the spring with which the point at the end of the tuning fork came in contact acted in the same manner as a fixed point would act, and if not, why not?

A. The contact spring is made flexible, in order that it shall not dampen the fork, which a rigid point would do, the object being to give as free a movement as possible to the fork.

16 Q. Please state in that connection, whether or not the action of a contact spring would be the same as you have stated in your last answer if a diaphragm was substituted for the vibrating fork?

A. If a diaphragm was substituted for the fork and a point was upon the diaphragm the action of the spring will be the same, the diaphragm being adapted to vibrate. There was an electric circuit running through the spring and the two contact points. There were one or two instruments made like EXHIBIT 8-3 and put in practical operation about November, 1875. I do not remember just how these instruments were put in circuit, but so far as this spring is concerned the vibrations of the tuning fork would allow of the current to pass in either one of two directions, the end of the vibrating spring acting to open and close the circuit when moved by the point on the fork. I signed and put the date on this EXHIBIT 8-3.

Nov. 16, 1875. In EXHIBIT 9-9 is represented a tuning fork upon a resonant case to the end of one prong of which a German silver wire spring is fastened, the other end of which is fast to an adjustable terminal the prong of the fork, the German silver spring being included in a closed circuit with a battery and sounder. The writing on the exhibit explains what Mr. Edison wished to do, namely, to increase and decrease the resistance of a closed circuit and produce a rise and fall of tension in such circuit by the difference in resistance of the German silver spring when its coils were touching each other or far apart. This instrument was made and worked satisfactory as far as I remember. I signed my name on this exhibit and wrote the date, Nov. 16, 1875, on the same about that date. EXHIBIT 10-9 represents a tuning fork mounted on a resonant case free to vibrate; on the top of the same case are mounted four levers with contact points at their ends which rest against four contact points fastened also on top of the case. A closed circuit is shown including all these points and levers and a battery and sounder. The object of the four contact points being that the vibrations of the tuning fork or of the resonant case would cause the contact points to slightly open or close, thus making a difference of resistance in that portion of the circuit, including the points and a rise and fall of tension in the circuit generally, the circuit never being entirely broken, and the sounder being operated by rise and fall of tension only. The upper left hand figure on Exhibit 10-9 represents a tuning fork with a point on the end of one prong pointing downwards in the direction of its vibration and touching a globe of mercury. Another point standing horizontally and pointing towards the mercury is also shown. It is intended to show that the vibrations of the fork will cause the mercury globe to bulge out and make contact with the horizontal contact point to a greater or less extent and thus produce a rise and fall of tension in a circuit in which these points and a globe of mercury are enclosed. I believe this experiment was tried by Mr. Edison

with one of the many forks or reeds that we had at that time, but do not remember the experiment clearly myself. EXHIBIT 22-9 is a drawing. The date, Dec. 29, 1875, and also the writing on the left hand top corner was put on by me. I, however, do not see my name there as a witness. The date is the correct date for the drawing. EXHIBIT 23-9 shows a tube or resonant case on the end of which is placed a strip of metal facing which is placed an electro-magnet. Above on this drawing is also shown another tube provided with a small coil and rubber pieces so as to be placed at the ear. This second tube is meant to slide inside the resonant case. There were three of these instruments made. The resonant cases were of different sizes and I believe the strips of metal were of different widths.

17 Q. Before this time, had any other instruments been made of a similar character, if so, what?

A. Previous to the making of these three instruments, two or three instruments were made corresponding to this EXHIBIT 22-9 in all respects except the strip or band of metal, instead of which, there was a diaphragm of iron secured to the edge of the tube, at the end and facing the electro-magnet, these instruments are now in evidence, and marked EXHIBITS A AND A'.

18 Q. State whether or not each of these EXHIBITS A AND A' is adapted, to render audible sensible vibrations of all kinds that may be translated into electrical vibrations in a closed circuit containing the electro-magnet?

A. Either of these Exhibits is capable of doing so, and one or both of them was used for some time in doing so, during a period extending from Nov. 1875 to the spring of 1876.

19 Q. Please examine the EXHIBIT 24-10, 25-10, 26-10, 27-10, 28-10, and 29-10, and state whether you identify either of them, and if so, which?

A. From about March, 1876 to the middle of Dec. 1876, I had to attend to business of Mr. Edison almost every day in New York, and consequently some experiments that were carried on in the day time I did not wit-

ness, or sign the drawings for them. I generally knew what was being done, and frequently helped during the nights. EXHIBIT 7-10 I have not signed, but I believe that a series of experiments were tried about that time in connection with a telephone that we always designated as water telephones, in which the transmitter varied the tension of the current in a closed circuit, by means of two electrodes, between which was placed water, or a salt and water, or other chemicals, and also paper saturated with different chemicals; also felts and other things, moistened with different chemicals. The movement of the diaphragm pressing more or less against these substances, caused their resistance to be decreased or increased proportionate to the amplitude of the vibration of the diaphragm. I remember such an instrument being used as two vibrating reeds and resonant chambers, in the manner shown on EXHIBIT 25-10, my name is not on this.

EXHIBIT 26-10 explains itself. I put my name upon it at the date, July 26, 1876, or thereabouts, but I do not remember whether the instrument was made. The instrument shown in EXHIBIT 73-10 I remember was made up four two or three other instruments. I remember the instrument, but as my name is not on the drawing I cannot say exactly when it was made. I have seen the drawing of EXHIBIT 106-10 frequently, but I do not remember whether the instrument was made or not.

29 Q. Please look through the other exhibits here present and name which ones you identify as having been made at the date which the respective exhibits bear, and which ones you have signed?

A. EXHIBIT 5-11, is one of Adams' drawings, and I do not remember whether the instrument was made exactly in that shape, but I know that for some time previous to my coming back to the laboratory in December, 1876, he had been working with just such methods for telephonic transmission. EXHIBIT 6-11, I identify by signature put on there February 6, 1877, or thereabouts; it illustrates a method of increasing and decreasing the

resistance of the current in a closed circuit by the movement of a diaphragm moving two springs, with rollers on their ends, on a film of phosphors or other conducting material, which film was part of the circuit, the movement of the diaphragm increasing the length of the film in circuit. That instrument I made myself, and it did transmit the human voice. The receiver used in this instrument was an electro magnet in front of a diaphragm placed in front of a resonant chamber, with an iron diaphragm on its end. This Exhibit is dated February 6, 1877, but I believe there was a previous drawing for this, as I remember that particular style of transmission. I commenced to perfect for Mr. Edison as soon as I returned to the laboratory to work altogether in the day time, which was before Christmas, 1876.

EXHIBIT 8-11, signed by me February 9, 1877, I remember the instrument being made, and that it worked, and the description written upon the exhibit when it was made is correct, and I believe that description has not been changed. EXHIBITS 9-11, and 10-11, and 14-11 and 15-11 are all signed by me. They illustrate the principle of cutting in and out resistances or batteries by means of a diaphragm or springs, in order to accomplish the rise and fall of tension of current in a circuit which always remains closed. I identify EDISON'S EXHIBIT 14-11 as the original instrument as represented on EXHIBIT 14-11. It was made by myself and Adams about the date of EXHIBIT 14-11, which was February 17, 1877.

EXHIBIT 16-11, 17-11, 18-11, 19-11, 20-11, 21-11, 22-11, 23-11, 25-11, 26-11, I identify as bearing my signature, put on it or about the dates which are on the exhibits and instruments were made corresponding to all the Exhibits just named, excepting 17-11, which I am not quite sure about.

28-11, 29-11, 32-11, 33-11, 34-11, 37-11, 39-11, I identify all these Exhibits, some by my signature, and others by their representing instruments well known to me as made at the dates shown on the Exhibits. Some

of them, also, as EXHIBITS 36-11, have writing which I wrote upon them. EXHIBITS 41-11, 43-11, 44-11, 46-11, 48-11, 49-11, I identify by my signatures upon the Exhibits, and instruments, were made corresponding to all of them, at or about the dates shown on the Exhibits. EXHIBIT 57-11, I recognize and identify as made April 10, 1877, by my signature thereon; this Exhibit represents a speaking telegraph, in which a resonant chamber with a diaphragm on its end held an electro-magnet on the centre of said diaphragm. This electro-magnet was vibrated with the diaphragm, and was kept excited by a battery. The magnet in its movement attracted an iron armature, which rested against a button or buttons of ebon, which were included in another closed circuit, with a battery and telephone receiver. The instrument worked very well, and translated the sounds of the voice perfectly. The instrument was made by myself and Adams.

21 Q. Please look at the instrument EDISON'S TELEPHONE RELAY 58-11, and state about when the same was made, and generally how it operated.

A. This relay, or one similar to it, was made previous to April 10, 1877, and was worked for some time on a regular telegraph line to Washington in the laboratory. Its operation is described in the Journal of the Telegraph, June 1st, 1877.

22 Q. Please identify any other Exhibits here presented?

A. I identify Exhibits 58-11, 62-11, 65-11, 70-11, 78-11, 82-11, 86-11, 87-11, 95-11, 99-11, 100-11, 101-11, 111-11, 102-11, 115 and 114-11, 115-11, 116-11, 120 and 121-11, 129-11, 130-11, 132-11, 133 and 135-11, 136-11, 139-11, 140-11, 141-11, 142-11, 143-11, 144-11, 145-11, 146-11, 147-11, 148-11, 149-11, 150-11, 151-11, 152-11, 153-11, 154-11, 156 and 157-11, 158-11, 159-11, 160-11, 161-11, 162-11, 163-11, 164-11, 165-11, 166-11, 167-11, 168-11, 169-11, 175-11, 173-11, 176-11, 177-11, 178-11, 179-11, 180-11, 182-11,

183-11, 181-11, 185-11, 186-11, 187-11, 188-11, 191-11, 192-11, 193-11, 194-11, 197-11, 198-11, 199-11, either by my signatures or by my handwriting on each Exhibit. The majority of the instruments illustrated by these Exhibits, were made and tested at or about the dates represented on the Exhibits, and were a continuation of experiments on speaking telephones.

Furthermore, I identify Exhibits 3-12, 7-12, 9-12, 10-12, 11-12, 12-12, 13-12, 14-12, 15-12, 18-12, 22-12, 24-12, 25-12, 27-12, 28-12, 31-12, 32-12, 36-12, 37-12, 38-12, 44-12, 46-12, 47-12, 48-12, 53-12, 54-12, 55-12, 56-12, 57-12, 58-12, 59-12, 61-12, 67-12, 69-12, 72-12, 76-12, 78-12, 80-12, 81-12, 86-12, 87-12, 88-12, 90-12, 91-12, 93-12, 94-12, 95-12, 96-12, 97-12, 98-12, 104-12, 109-12, 111-12, 113-12, 115-12, 116-12, 119-12, 121-12, 124-12, 127-12, 129-12, 131-12, 132-12, 135-12, 136-12, 138-12, 142-12, 144-12, 145-12, 146, 147 and 148-12, 152-12, 159-12, 160-12, 161-12, 162-12, 164-12, 165-12, 167-12, 171-12, 173-12, 174-12, 177-12, 179-12, 181-12, 182-12, 184-12, 185-12, 186-12, 1-13, 2-13, 4-13, 5-13, 6-13, 7-13, 8-13, 9-13, 10-13, 12-13, 13-13, 15-13, 16-13, 18-13, 20-13, 27-13, 29-13, 30-13, 33-13, 34-13, 35-13, 37-13, 38-13, 39-13, 40-13, 41-13, 42-13, 43-13, 45-13, 47-13, 51-13, 55-13, 66-13, 67-13, 68-13, 69-13, 75-13, 71-13, 72-13, 73-13, 74-13, 75-13, 76-13, 77-13, 79-13, 80-13, 82-13, 94-13, 95-13, 96-13, 98-13, 102-13, 104-13, 110-13, 114-13, 115-13, 116-13, 117-13, 120-13, 121-13, 124-13, 125-13, 126-13, 127-13, 128-13, 131-13, 133-13, 134-13, 137-13, 138-13, 140-13, 150-13, 151-13, 152-13, 153-13, 155-13, 169-13, 161-13, 162-13, 163-13, 164-13, 165-13, 166-13, 170-13, 202-13, 203-13 and 160-14, either by my signature or by my handwriting on each exhibit. The majority of the instruments illustrated by these exhibits were made and tested at or about the dates represented on the exhibits, and were a continuation of experiments which resulted in a perfectly practical speaking telephone.

23 Q. Please examine the instrument exhibits here present, and state which, if any, of them you recognize

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in addition to A and A', to which you have already testified?

A. "EDISON'S EXHIBIT CARBON RING STAT" was made and used as far back as 1873, I believe. It was used as a resistance for some cable experiments. In this case the carbon acted as a resistance in the electric circuit, and the resistance was greater or less according to the compactness of the carbon.

"EDISON'S EXHIBIT D" was made about November or December, 1875, and was used as a telephone receiver. The strip of metal that passed across the end of the resonant tube was polarized by the permanent magnet to which it was attached, and was clamped in front of the resonant tube by an electro magnet worked by an induction current from the distant station. The instrument was used, but I do not remember with what degree of success. As far as I can see, the instrument is now in the same condition as when made, except from the effects of rust and dirt and the parts have become loose.

"EDISON'S EXHIBIT A' TUBE" I recognize as belonging to three instruments spoken of as having been made in December, 1875. The instrument marked "EDISON'S EXHIBIT WATER TELEPHONE," I believe, was made by Adams previous to the month of October, 1876. I do not remember the instrument

702 being made, but I remember his working for a long time on the principle of transmission that is illustrated by this Exhibit. This instrument, except in the looseness of its parts, and its lack of adjustment, remains the same as far as I know, as when first seen by me. Some time after I came back to work in the laboratory, which was before Christmas, 1876, this instrument I believe was taken down from a shelf and recognized by Adams at the time as one that he had made previously. I think Adams found the instrument himself, and I do not believe it was made in the laboratory during the time intervening between my coming back and

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its finding. "EDISON'S EXHIBIT 117-118" I remember being made. I recognize it as one that was made and used about Nov. 18, 1877. It consisted of a paper strip moistened with a chemical solution kept in a chamber underneath, which paper strip was held between a platinum electrode on the top of the cell and a platinum fused spring fastened to a diaphragm, and two electrodes of platinum, and the moistened strip being included in a closed circuit of a telephone transmitter. "EDISON'S EXHIBIT INSTRUMENT 10-11" is part of an instrument in which the cutting in and out of resistance or battery was used to vary the tension in a closed electric circuit. These springs being made to throw in and out such resistance or battery by the vibrations of a diaphragm actuated by the human voice. "EDISON'S EXHIBIT INSTRUMENT, 112-13," is part of an instrument that was made about Nov. 16, 1877, and consists of a small spool of German silver wire mounted upon a rubber plate which rubber plate was arranged on the instrument so as to be adjustable to and from a diaphragm in front and lengthwise with this spool was placed a spring, which was fastened to a metallic post at one end of the spool. The other end of the spring being free to move against the spool so as to touch one or all convolutions in the whole length of the spool. The free end of this spring was fastened to and actuated by a connection to the center of a diaphragm and speaking chamber. The object of the instrument being to vary the tension of a current of electricity in a closed electric circuit by means of cutting out or putting in more or less of the convolutions of the wire on the spool, the said spool being enclosed in a constantly closed circuit, with a magnet battery. I remember the instrument and that it worked well. "EDISON'S EXHIBIT INSTRUMENT 121-12" is part of an instrument which works similarly to EXHIBIT 112-13, the difference being that in this case the spring was made to have a greater or less intensity of contact upon a strip of platinage in the form of a pencil lead in place of the spool

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shown in INSTRUMENT 112-13. The strip of pencil lead was included in a circuit similar to the spoon spoken of in 112-13, and the action of a spring was to make connection with more or less of the lead, and allowing part of the current to go through the spring instead of the lead, thus altering the tension of an electric current in a constantly closed circuit.

The instrument shown "EDISON'S EXHIBIT INSTRUMENT 67-13 is part of an instrument which I well remember Mr. Adams making and trying with different chemicals, and papers soaked with chemicals, as a telephone transmitter. The lever holding the felt washer projected out a little further, as shown in Exhibit 67-13, and was connected to the diaphragm and speaking chamber. I do not remember what results were got with this instrument, but I remember to see by him. EDISON'S EXHIBIT INSTRUMENT 22-13 is an instrument made about Oct. 17, 1877, and is illustrated by a series of sketches marked 21-13, 22-13, 23-13, 24-13, 25-13. My name is not on these sketches, but I remember them being made in the Western Union Telegraph office, in Jersey City, on that date. The instrument consists of a polarized U-shaped bar, to one extremity of which is fastened a diaphragm and resonant chamber, and to the other extremity of the U-shaped bar, which is shorter than the first, is pivoted a bar of iron, which is free to move towards and is directly opposite the center of the diaphragm. Across the U-shaped bar is a hard rubber bridge, carrying at its center and towards the center of a diaphragm, a brass adjusting screw, in the end of the brass adjusting screw, nearest the diaphragm, has been a carbon button, on which the aforesaid pivoted lever was held by a spiral spring. This carbon button was included in a closed circuit with a battery; the action of this instrument was as follows: When not in use the lever pressed upon the carbon button with an initial pressure, and the two were adjusted close to the dia-

phragm; when the diaphragm was actuated by the voice, it approached nearer and receded from the lever, altering its pressure on the carbon button by the movement of the diaphragm, acting by magnetism, on the lever that pressed upon the carbon, thus varying the tension of the electric current in a closed circuit, of which the carbon is a part. I recognize the two diaphragms marked "EXHIBIT IRON DIAPHRAGM AND SPRING," and "EXHIBIT IRON DIAPHRAGM" as two of the diaphragms that we used in our experiments. "EDISON'S EXHIBIT INSTRUMENT 36-13," I recognize as an instrument that was made about Sept. 22d, 1877, and it is illustrated on the drawing marked EDISON'S EXHIBIT 36-13. It is a good telephone transmitter, and works in the following manner: A diaphragm fastened to a resonant chamber, has at its center a number of silk fuffs, coated with platinum, or carbon, a lever pivoted on one side of the diaphragm, and reaching across in face, is free to move to and from the diaphragm. In the center of this lever, and fastened to it, is a small hard rubber cup, carrying an electrode, and enclosing silk "duffs" on the diaphragm; this lever is adjustable to and from the diaphragm by a spring at the other extremity of it. The tension of the lever being adjustable by a nut on a screw passing through such spring. The platinum fuffs were included in a closed circuit with a battery and the tension of the electric current in this closed circuit by the pressure of the diaphragm upon the platinum fuffs when it was vibrated by the human voice. I recognize "EDISON'S EXHIBIT INSTRUMENT 100-11" as one of the springs used in an instrument that was made and used about May 25, 1877, and illustrated by the drawing on EDISON'S EXHIBIT 100-11. The instrument worked well. "EDISON'S EXHIBIT INSTRUMENT WEIGHTED ELECTRODES" I recognize as part of the weights used in experiments on inserting the telephones. "EDISON'S EXHIBIT INSTRU-

MENT 149-12." I recognize as an instrument made as one of a number of carbon telephones made with hard rubber cases. I believe they were made about or previous to Nov. 26, 1877. The working of this instrument is first rate in every respect, with the exception that a difference of temperature after talking a little while alters the adjustment slightly by expanding the case. There were, therefore, not a great many of these instruments made, the one shortly being changed to an iron one. "EDISON'S EXHIBIT INSTRUMENT 120-11" is what is known as one of the first practical nograph telephones. It consists of a brass rule, one end of which was covered by a diaphragm in front of this diaphragm and adjustable.

713 Towards it was a spring electrore carrying a button of phonology, the vibrations of the diaphragm causing a greater or less intimacy of contact with the phonology button, and increasing and decreasing the tension of an electric current in a closed circuit, in which the phonology button and electrore were inclosed with battery. The brass rule of this instrument is bent in such a manner that it can be used in a resonant chamber, which constitutes a portion of the receiver of the same instrument. "EDISON'S EXHIBIT MOTOPHONE" I recognize as one of the speaking telephones now in use and is the most practically speaking telephone on this principle. There have been a large number of them made during the last 15 months, which are at present in use.

714. 24 Q. Referring to the publications shown as Exhibits in this case, and marked A, B, C, D, E, F, G, H, I, J and K, what do you know about them?

A. They were published in the papers stated, and at the times named, from which I cut them out; they have been in my possession ever since. They are as follows, all except K:

A. An article headed "Edison's Pressure Relay," cut from the Journal of the Telegraph, June 1st, 1877.

B. An article cut from the Journal of the Telegraph, New York, and dated July 16, 1877.

C. An article cut from the Sunday Trojan, Troy, N. Y., the date of which was Sept. 24, 1877.

D. An article cut from the Cleveator (Pa.) Evening News, and which was dated Sept. 28, 1877.

E is a programme of an Exhibition of Edison's Telephones, musical and speaking at the Teleroute, Jersey City, on Thursday evening Oct. 18, 1877.

F is an article cut from the Daily Graphic, of New York, dated April 17, 1877, and headed, "Testing the Telephone."

G is clipped from an article in the Washington Post and Union, April 13, 1878, and headed "Genius Before Science."

H is an article from the Telegraphic Journal of London, dated January 1st, 1878, and is a resume of telegraph work done in 1877.

I is an article cut from the New York Daily Tribune of April 29, 1878, headed "Academy of Sciences."

J is an article cut from the New York Daily Graphic of April 26, 1878, and is headed "Telegraph and Telephone."

K is an article cut from Scribner's Monthly, and is headed, "The Telephone and Telegraph."

25 Q. Please look at EDISON'S EXHIBIT 191-11, and state what the upper figure thereon shows, if you know?

A. The drawing referred to represents a diaphragm with rubber rings on each side of it, on each side of its edge. Such an instrument was made by myself or James Adams, about the time of the date of this drawing.

26 Q. Please give the date of the drawing, and state whether or not your signature is on the same, and whether or not the drawing is in the same condition as it was when originally made, with the exception of the notary's mark, "EDISON'S EXHIBIT 191-11, S. L. G. 2."

A. The date on the drawing is June 30th, 1877; my name is upon the drawing, and it is in the same condition.

tion, to the best of my belief, as when made, with the exception referred to. I put my signature on it about the date marked on the drawing.

27 Q. Please state whether the telephone instrument that you have referred to with the rubber rings on each side of the diaphragm, was ever made use of, and if so, with what result?

A. The instrument worked well.

28 Q. What was the object of the rubber rings?

A. To increase the amplitude of the vibration of the diaphragm, and also to deaden the metallic harmonic vibration.

710 29 Q. About what time was this instrument made and used?

A. Shortly after the date of the drawing, viz.: June 26, 1877.

30 Q. Please look at the drawing, "EDISON'S EXHIBIT 37-12," and state whether your signature is on the same, when the drawing was made, and what it shows?

A. My signature is on the same; I signed it about July 29, 1877, and it shows a number of different shaped diaphragms and bands on diaphragms of rubber.

It also shows a diaphragm placed between rubber rings, out at the edge of the diaphragm. Also three small drawings illustrative of these rings, in order to instruct more fully the experimenter who uses it. These three drawings are marked, one as the outside ring, another as the inside ring, and the middle, the diaphragm; it also gives farther instructions in writing, which says, "put rubber or other soft substance rings between diaphragms on the rings."

720 31 Q. Please state whether or not a telephone instrument was made with the devices shown upon "EXHIBIT 37-12;" and, if so, about when, and whether or not there are several forms of diaphragms and rubber illustrated on said "EXHIBIT 37-12?"

A. Telephone instruments were made, I believe, similar to all shown in these drawings, and many more, about the time of the date of this drawing, July 29, 1877.

There are several forms of diaphragms and rubber illustrated. In the four upper figures the rubber is shown as a complete disc, upon which the diaphragm portion rested. In the device shown, the rubber was simply in the form of rings, the diaphragm being between them.

32 Q. Please refer to "EDISON'S EXHIBIT 164-12," and state whether you signed the same, and when, and whether or not it is in the same condition as it was when you signed it, and what the same represents?

A. I signed that about Sept. 21, 1877. It is in the same condition, I believe, as when I signed it except the addition of the Notary's mark in the left hand lower corner. This mark is, EDISON'S EXHIBIT 164-12, S. L. G. This drawing shows a loose diaphragm, resting on a stretched diaphragm of rubber to be used in a telephone.

33 Q. Please examine the telephone instruments marked "EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877, S. L. G., and "EDISON'S THREESPRING ELECTRODES, S. L. G.," and state whether you ever saw the same before, and if so, about when?

A. The instrument marked "EDISON'S ARTICULATING TRANSMITTER, OCTOBER, 1877," is one of a number of instruments made on the principal marked in "EDISON'S EXHIBIT 164-12." A number of these were made about the date of the drawing marked "EDISON'S EXHIBIT 164-12." I recognize this instrument as one of the original ones, and, as far as I can see, is in the same condition as when made, with exception of the case enclosing the back. This Exhibit, marked "EDISON'S EXHIBIT THREESPRING ELECTRODES" I recognize as an experiment tried by Mr. Edison, about October, 1877. It is not in the condition as originally made, as I see the rubber diaphragm has broken away and only the edge around where it is fastened to a screw. The carbon buttons also, I see, are gone. I remember this instrument.

34 Q. Please examine EDISON'S ARTICULATING TRANSMITTER, and state whether or not this subject

matter of the counts in Case 4, and the first one in Case 5, are contained therein?

A. They are.

35 Q. Please examine "EDISON'S EXHIBIT 105-12," and state whether that is your signature where the same is applied, and whether or not any change has been made in the same since it was signed by you?

A. That is my signature, and the sheet is the same as when I put my name upon it, about August 12, 1877, with the exception of the notary's mark, EDISON'S EXHIBIT 105-12. S. L. G.

36 Q. Was any instrument made, and, if so, when, in the form illustrated by the middle figure, and described in the statement: "Soft rubber to dampen the diaphragm. It works well, prevents harmonies or excessive vibrations?"

A. Yes, sir; such an instrument was made and the soft rubber was applied to the diaphragm by stretching two strips of it across the face of the diaphragm; one a little above and the other a little below the centre. This instrument was made August 12, 1877, and worked well.

37 Q. Was any other form of device proposed for damping the diaphragm besides the strips of rubber?

A. Yes, sir; in connection with this instrument, Mr. Edison proposed and wrote out the following: "Hard pieces of rubber or equivalent material could be placed in different parts of the diaphragm, and held against it by adjusting screws to dampen it." Such a device was subsequently employed. I refer to "EDISON'S EXHIBIT 9-13, S. L. G.," in the upper figure of which is represented a diaphragm dampened by screws and sections of rubber tube.

38 Q. State whether or not your signature is on this EXHIBIT 9-13, and whether or not the same is in the same condition it was in originally as signed by you?

A. My signature is on this EXHIBIT 9-13, and was put on about October 14, 1877. The Exhibit is in the

same condition as when I signed it, I believe, with the exception of the notary's mark.

39 Q. Please state what EXHIBIT 184-11 represents, and how it was used?

A. The Fig. in EXHIBIT 184-11 shows a spring carrying an electrode to be used in connection with a telephone diaphragm. The object of the rubber between the ends of the U-shaped spring was to develop the vibrations peculiar to the spring itself, and for this purpose there was also used about June 25, 1877, rubber rings placed around the slank of the U shaped springs. This I consider to correspond with the count in "Interference H 3."

40 Q. Please state whether or not the diaphragms represented in EDISON'S EXHIBIT 136-12 were loose, so that they might be free to play under the atmospheric vibrations?

A. The two figures nearest the left hand bottom corner of this Exhibit show loose diaphragms—the higher one having a limited movement so that it would not drop off if held downwards. The lower figure shows the diaphragm resting on a ring of rubber. This diaphragm, although not shown here, was held by a spiral spring from its center inwards. I believe it was also tried loose.

41 Q. Please look at EDISON'S EXHIBIT "SPRING FINGER," which drawing was made by the witness when giving his testimony, and state whether or not you ever saw a telephone instrument such as is illustrated in such Exhibit, with a loose diaphragm resting upon rubber and having spring fingers to hold it to its seat?

A. I remember such an instrument, such as shown in "Edison's Exhibit, August 1, 1877," and believe it was made about August, 1877.

42 Q. State whether or not that instrument was practically operated?

A. Yes, sir, it was. It was very satisfactory.

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421 Q. Please look at EDISON'S EXHIBITS 1-13, 7-12 and 16-18, and state, generally, what the same represent, and whether or not any apparatus was made corresponding to the same?

A. Yes, sir; instruments were made corresponding to the middle fig. and left hand fig. in EXHIBIT 1-13; and instruments were made like all the devices shown on Exhibit 7-13; and instruments were made like the bottom fig. shown on Exhibit 16-18. All of these instruments were practically good talking telephones. The lower right hand fig. of Exhibit 7-13 shows an instrument in which the diaphragm holds in its center one electrode, whilst the other electrode is fastened to a spring on which a rubber tube is pressing. In this case there are two springs, the diaphragm also forms a spring, which would correspond with the second count of Case 5, the server for adjustment being equivalent to the lever spoken of in said count. The device shown in EXHIBIT 16-13 I also consider to correspond with the same count. In some instances Mr. Edison made use of a lever instead of an adjusting server, as shown in "Exhibits 36-15," and also in the left hand figure, "Exhibit 11-13."

43 Q. Please state whether or not any instrument was made corresponding to Edison's "Exhibit 36-13?"

A. Yes, sir. An instrument was made similar to the lower figure.

44 Q. Please examine the exhibit marked "EDISON'S EXHIBIT LOOSE DIAPHRAGM, SEPT., 1877," and state whether or not the same is one of the original instruments containing the loose diaphragm, and about when the same was made?

A. The instrument marked "Loose Diaphragm" is one of the original instruments, and was made about Sept., 1877, I believe.

45 Q. Please refer to the instrument marked "EDISON'S MUSICAL TELEPHONE, SEPT., 1877," and state whether you ever saw the same before—when it

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was made, and the manner in which the diaphragm is held in place?

A. I have seen the instrument before, and I believe it was made about Sept., 1877. The diaphragm is held in place with rubber rings on each side, near the outer edges.

Q. 46. I now show to you a copy of the drawing in Mr. Edison's application No. 188, filed December 31, 1879, and ask you whether or not you ever saw a telephone receiving instrument corresponding to the same; if so, when first and where?

A. I remember such an instrument being made by Charles Edison previous to his going to Europe, and listened to the talking received on it.

Q. 47. Will you please state the month, as near as you can recollect it, when you saw the said instrument, and whether or not you saw it on more than one occasion?

A. I believe it was in either January or February, 1879. It was one of a large number of experiments that he made which I was generally asked to listen to.

Q. 48. State whether or not articulate words were received by this instrument?

A. I received good talking, but very low.

Q. 49. On about how many occasions did you listen to a telephone of this character?

A. I cannot say, as it was not up very long.

Q. 50. Did you understand how this telephone operated?

A. Yes, sir.

Q. 51. Please describe the same?

A. When the magnet was turned and the lever rested on it, a current through the spool would make more or less drag to the lever, causing it to vibrate the diaphragm in answer to such differences.

Q. 52. If there is a permanent current through the spool or helix, and the strength of that current is varied, will that vary the friction of the rotating screw against the arm extending from the diaphragm or not?

A. Yes sir; I should judge so.

Q. 53. If the rotating core is a permanent magnet, and the current through the spool or helix is varied, will that act in the same manner or not in varying the friction between the rotating core and the arm?

A. It will act in the same manner.

Q. 54. In the instrument that you saw, do you know whether or not the core was soft iron, forming a rotating magnetized bar, by the action of the current in the helix, or whether the said core was permanently magnetized?

A. I do not remember, but I think both were tried.

Q. 55. I now show you EDISON'S EXHIBIT 139-14, and ask you whether you ever saw the same before?

A. Yes, sir, I have, on or about the date that is marked on the top of the page, namely, July 18, 1879.

Q. 56. Do you know how it happened that you saw the same at that time, and is that your signature affixed to it?

A. That is my signature on it. I don't remember how I saw it at that time. It is my signature on it, and I presume it was put on at the time I first saw the drawing.

Q. 57. Did you or not, on July 18, 1879, understand the instrument that that drawing was intended to represent, and if so, what is the difference, if any, between the same and the instrument shown in the application of

738 Mr. Edison, No. 188, now in interference?

A. I did understand it at the time; there is no substantial difference between the two.

Q. 58. Do you remember whether or not the induction coil was used with the instrument made by Charles Edison, and which you saw in January or February, 1879?

A. Yes sir; all his experiments, as far as I know, for a receiver, are constructed with an induction coil, with its second coil in the line.

Q. 59. I now show you Mr. Edison's sketch, marked

"EDISON'S EXHIBIT MAGNETIC MOTOGRAPH TELEPHONE," and ask you whether or not you remember seeing any instrument or drawing corresponding thereto?

A. I do not remember any instrument being made like that, but believe I have seen a similar drawing to that.

Q. 60. Did you work with, or give instructions to Charles Edison, when making the instruments now in controversy?

A. He worked directly under Edison, but Edison being so deaf, I was frequently called on to listen to his experiments, after which I frequently gave him instructions. I had other work to do, however, that took the most of my attention.

Q. 61. Did you know anything in relation to telephone receivers operated by friction in the manner shown in Mr. Edison's patent No. 221,057?

A. Yes, sir.

Q. 62. Do you know to what extent, and with what success the manufacture of instruments corresponding to Edison's patent 221,057 was prosecuted?

A. I know there have been a large number of them made, and they are to-day working and are very successful.

Q. 63. Do you know when instruments like those in the said patent were first made corresponding to the form in which are now successfully in use, and about what period of time was occupied by Mr. Edison, and in his behalf, in bringing his instruments to this successful operation?

A. The instrument in that particular form was completed about Jan. or Feb., 1879. Instruments working on the same principle had been made by Mr. Edison previous to that. They were put on the market for actual use a little later. The instruments in the form now used by the public were made in either March or April, 1879.

Q. 64. Look at Edison's Exhibit 43-11; state whether it bears your signature?

A. Yes, sir, it does.

65 Q. When and by whom was the drawing made, and when did you sign it?

A. The drawing was made by Mr. Edison on or before April the first and signed by me on that date, or within a day of that date.

66 Q. Did you make the apparatus shown in that sketch on the top of that paper, which Mr. Edison testified is more fully shown on figure 260, page 534; of the 2nd edition of Mr. Prescott's book on the speaking telephone?

A. I, in conjunction with James Adams, now deceased, made that apparatus.

67. Did you use it after it was constructed, and how?

A. I did. I used it with James Adams and Thos. A. Edison, as a transmitter for a telephone circuit.

68 Q. What did you transmit with it, and with what success?

A. We transmitted ordinary speech perfectly.

69 Q. Did Mr. Edison have any difficulty or any physical trouble which made experimenting with him in speaking telephones difficult, if so, what?

A. Yes; it was very difficult to experiment with Edison owing to his deafness; perfect talking, if very low, was no talking at all to him, because he could not hear it.

70. Of what material were the different parts of the instrument described in your 66th answer constructed?

A. The springs were made of steel, about 2 inches long and 1.60 of an inch thick, and about 3-8 of an inch long; the bottom end of these springs was fastened to brass about 5-16 of an inch square and 3-8 of an inch long, with an elongated hole in them, so that the spring could be screwed to an insulating bar and adjusted to position. The other end of the spring carried a brass sleeve projecting about 1-8 of an inch from each side, in which was pressed tightly a hard pressed bottom of phumage. This was afterwards filed down on each side

so as to project about 1-16 from each end of the sleeve. There were five of these springs in the instrument. The diaphragm of the instrument was about 3 and 1-2 inches and the speaking case was turned from wood. The diaphragm being held to the case by a brass ring. This whole apparatus was placed on a base with the springs upright. The electric circuit passed in at the bottom of the spring nearest the diaphragm, thence through all the phumages and passed out at the bottom of the farthest spring from the diaphragm. The springs themselves were made by Adams.

71 Q. What has become of that instrument?

A. Most of the parts of that instrument have been used in other experiments, only a few of them being able to be found at present. After an experiment is tried in the laboratory it is usual with us to use as much of the instrument as can be used in making the next experiment.

72 Q. The drawing is dated April 1, 1877; how soon after that date did you make and use this apparatus?

A. It was made within two or three days of that date, and I believe was made before the next morning after that date.

73 Q. At the time you made this apparatus what was your belief as to the importance of arranging a battery transmitter of an electric-speaking telephone so that its electric wires would or would not break contact when the instrument was talked in?

A. At that time it was my belief that no instrument that broke the electric circuit would ever transmit speech perfectly. Mr. Edison's idea in this particular case I understood to be not to break contact under any consideration, as from previous experiments we had found it a bad thing.

74 Q. Upon what did you rely to prevent these five carbons from breaking contact at the four places of contact between them and through which the current had to pass when they were agitated by the vibrations of the diaphragm?

*Edison
diag.*

A. We relied upon the springs holding the plumbago pieces. These would certainly have separated by their momentum, which we wanted to use but to keep under control. That, I believe was Edison's idea when he gave us the drawing.

749 Q. Look at EDISON'S EX. 106-11, marked May 26, 1877. State whether it bears your signature, and, if so, say when and by whom the drawing was made and when you signed it, and whether the drawing was there when you signed it.

A. The Exhibit was signed by me on or about May 26, and the drawing was on the paper when I signed it.

750 Q. The drawing was made by Mr. Edison.

751 Q. Did you construct an apparatus substantially like that drawing, and when, and if so, what use did you make of it after you had constructed it, and with what success?

A. I did, slightly different from the drawing, but practically the same. As an instrument, the instrument did not give any satisfaction at the time, the talking not being good, even to myself.

752 Q. What did you then consider to be the cause of the bad result with it?

A. I have not in my mind just at present why this did not work, and think that it was tried a very short time.

753 Q. What were the electrodes made of?

A. Platinum.

754 Q. Look at the drawing now shown you marked EDISON EX. 112-11, dated May 31, 1877. State whether it bears your signature when you signed it, whether the drawing and date were on the paper when you signed it, and who made the drawing?

A. Mr. Edison made the drawing, and my name was put on by me on or about the date marked on the paper. The drawing and date were on them when I signed it.

755 Q. Did you at any time construct the instrument as there drawn; if so, when, and of what material were the parts made?

A. I, with Adams, constructed the instruments substantially as here shown, on or about the date shown. It consisted of a cup of brass, in which was held a solid cylinder of plumbago, the cup of brass being fastened to a spring at first of wood, on this spring a piece of hard rubber insulating material, with a platinum spring fastened to it, the platinum pressing against the face of the plumbago. This spring of wood was placed in such a position that the platinum spring rested against, and put an initial pressure on a diaphragm, which was secured to a speaking tube, the diaphragm in this case being about 2½ inches, but I believe we tried it with larger diaphragms about that time, after wards. The electric circuit passed in at the platinum spring through the plumbago button or cylinder, and out from the brass cup.

756 Q. I notice in that drawing some kind of a block fastened to the diaphragm; what was that for, and did you put that in the instrument that you made?

A. I do not believe the block was on the diaphragm, but I think Mr. Edison's idea in putting it there in the drawing was that it would reach out far enough to prevent any other parts of the instrument from touching the diaphragm or case.

757 Q. Did you make any use of the instrument constructed as you have described; and if so, what use, and with what results?

A. Yes, we made use of the instrument as a transmitter of speech, with good results.

758 Q. Did you afterwards make any change in that instrument, and if so, what was the first change you made?

A. The first change that we made in the instrument was to make weights for the end of the lever, to alter its period of vibrations. I believe the first thing like a fault in this instrument was its peculiar sensibility to the explosive elements, and we made a number of weights that we could slip into a screw stud and weight the end of a lever to prevent this. The stud was placed on the

opposite side of the spring from the plumbago cylinder, and directly opposite, and was about 2½ inches long; it was provided with a nut to keep the weights from coming off.

84. Q. What results did you find from this change, —the addition of this weight?

A. I do not believe that we noticed any change, that is, for better talking. Myself and Adams being able to receive any conversation sent by means of this transmitter before the change.

85. Q. What effect did this change have, if any, upon the trouble which you had noticed when the explosive resonators were altered into this transmitter.

A. I do not remember that it modified them. They were not so bad but that we could get the talking very plain.

86. Q. I notice that several of these drawings bear the signature of Mr. Adams; are they his signatures, and is he the Mr. Adams spoken of in this deposition?

A. Yes, sir.

87. Q. I call your attention to the middle figure on sheet, of July 5, and the middle figure on sheet, July 7, and various figures on sheet of September 21, and sheet of September 22; did you ever make any instrument substantially in accordance with those figures, and, if you made more than one, please describe them in the order in which you made them?

A. The instrument marked Ex. 2-12, I believe, was never made in the way shown on this Exhibit, but I remember Mr. Adams fastening by threads a plumbago button to the centre of a diaphragm, as shown on Ex. 6-12. This instrument, I believe, he made in place of the one shown on Ex. 2-12, as being easier to make. The description of the instrument is as follows: A small cylinder of plumbago is held to the diaphragm by a small, thin, platinum plate, which is held there by threads; I believe three or four threads were used in place of the two shown in the drawing. The object of the plate can be

end of the cylinder was for the wire leading to the end of the cylinder to make contact with. I believe I listened to the talking in that instrument, and also talked in it. The size of the diaphragm in that instrument was about 2-24 inches in the clear.

I should say, in regard to that instrument although the instrument marked on Ex. 2-12 was never made, and that the instrument on Ex. 6-12 was made, I mean that the plumbago cylinder held to the diaphragm by threads, as shown in Ex. 6-12 was used in connect with a speaking tube standing upright as in Ex. 2-12. The electric circuit passed in at the diaphragm through the plumbago cylinder or first entered the instrument at the small platinum plate on the outside end of the plumbago cylinder, thence through the plumbago cylinder to the diaphragm, from which it passed out. The instrument shown in Ex. 165-12 (Sept. 21, 1877), marked 1 and 4, I do not think were made. The instrument No. 2, I believe was made by Adams and it worked well. The instrument No. 3 was also made by Adams, I believe from the parts of the instrument No. 2.

88. Q. Were the drawings No. 1 and No. 4 on that sheet substantially different from or substantially the same as the drawing on Ex. 6-12 and 2-12, which you have just described, so far as relates to the principle and mode of operation of the apparatus?

A. Yes. They were specially designed for the special purpose of getting an increase and decrease of contact by momentum and inertia.

89. Q. In No. 2 and No. 3 of sheet Ex. 165-12 what if anything was relied on for inertia to hold the carbon button against the rapid vibrations of the diaphragm?

A. A body of air was relied on in addition to the weight of the electrode.

90. Q. In No. 2 and 3 of that sheet what is the curved line the two ends of which rest on or near the diaphragm?

A. The curved lines spoken of represent threads or

strings which were fastened, I believe, in No. 2 to the ring holding the diaphragm and in No. 3 to small hooks fastened to the face of the diaphragm a suitable distance from its centre.

91 Q. Please state whether you ever made any instruments substantially in accordance with the figure of Ex. 188-12, dated Sept. 23, 1877?

A. Yes, we did; the instrument that was made about that time was substantially the same as shown in figure 1.

It consisted of a hard rubber sleeve fastened to the diaphragm on the outside of which was a screw thread. A hard rubber cup with screw-thread inside fit d into this

701 In the inside of the cup on the diaphragm and next to it was placed a plumbago coated pad of silk; next to which was placed a circular weight and between the weight and the end of the cup was placed a spiral spring. The circuit was connected to the diaphragm, from thence through the plumbago, thence through the weight and spring to which was soldered the wire leading from the instrument. This instrument I believe we tried with hard carbons, with plumbago and I believe soft lamp black pressed.

92 Q. In using the different instruments described in your 87 to 91 answers inclusive, in what position did you hold the diaphragm,—horizontal or perpendicular?

A. The instrument that was made as a combination of Ex. 6-12 and 2-12 had its diaphragm in a horizontal position, the instruments Nos. 2 and 3 on Exhibit 105-12 and also No. 1 on Exhibit 188-12 was in a vertical position.

702 93 Q. Please state what results you obtained as to the transmission of articulate speech by the instrument referred to in your last answer?

A. In all these instruments good talking was obtained.

94 Q. State whether or not the instruments which you made and tried substantially in accordance with the Ex. 188-12, is or is not described with substantial accu-

racy in the passage in Mr. Edison's English Patent 2,339, quoted in one of his answers?

A. Yes, sir; it is.

95 Q. How soon after the dates of these respective papers were the instruments referred to in your 93d answer made and tried?

A. Within a few days of the date on the paper. I generally received them immediately after my own signature was on, and Adams and myself went to work at them immediately.

96 Q. In your 88th answer you say that these forms of instrument were specially designed for the special purpose of getting an increase or decrease of contact by momentum or inertia, state whether or not before July 5, 1877, you had constructed in accordance with Mr. Edison's instruction any apparatus in which use was made by inertia or momentum of the electrode not attached to the diaphragm for the purpose of varying contact between it and the electrode attached to the diaphragm, when the diaphragm vibrated?

A. Yes, sir; such an instrument is shown in one of the Exhibits here to-day, and that instrument was described by me yesterday. It is shown in Exhibit 119-11 May 24, 1877. In this instrument a very strong spring was used to prevent the breaking by its inertia the too sudden change of contact. After this instrument was tried a number of weights were added to the end of the spring to increase its inertia.

97 Q. If any parts of that instrument are here present as Exhibits, please identify them, if you can?

A. There are; the cup and plumbago cylinder marked "EDISON'S EXHIBIT CUP AND CARBON, 112-11," and also some of the weights, marked "EDISON'S EXHIBIT WEIGHTS, 112-11."

98 Q. Can you tell me how many more weights there were used on that instrument, beside the six produced as Exhibits?

A. I cannot at present remember how many were

made, but I believe there were a few more used than what we have here.

99 Q. Please state the weight of the Exhibits referred to in your 97th answer?

A. The weights marked "EDISON'S EXHIBIT WEIGHTS 112-11," weigh about one hundred and eighteen grammes, and the cup and carbon about 59 grammes.

100 Q. Do you know when instruments having diaphragm and electrodes like "Edison's Exhibit Mica Diaphragm," were first made for commercial purposes?

751 A. I believe a number of these instruments were made in Edison's Laboratory about June 1879. They were made for the "Edison Telephone Company, Limited, of London."

101 Q. In trying these telephones as you have described, where did you place the transmitter, and where did you place the receiver?

A. The transmitter was generally placed in the early part of our experiments in the front part of the bottom floor of the Laboratory Building, and the receiver in the back part of the top floor. Afterwards this was reversed. The distance apart is about one hundred feet.

102 Q. Did you ever place them any further apart than that?

752 A. Yes. Occasionally we took the transmitter to either Adam's or my own house, and sometimes to the depot, where private lines ran from the Laboratory.

103 Q. You have said that these different transmitters that you have described, transmitted articulate speech successfully. Why did you not go on and make more of them, and put them to public use?

A. I believe these instruments did not come up to what Mr. Edison had made in his mind as a standard of a commercially successful telephone. Some of them, although talking perfectly, when Adams and myself were working with them, not being thought good enough by Mr. Edison. If a telephone, for instance, was not a loud

telephone, it was practically useless to him on account of his deafness.

104. Were there any telephones at that time, in the summer and autumn of 1877, in public use with which telephones constructed by Mr. Edison would have to go into commercial competition?

A. I believe there was.

104½ Q. What other telephones were there?

A. I only know of the Bell telephone.

105 Q. Did Mr. Edison at any time have any telephone instrument made by any other party so as to institute a comparison between the same and his own?

754 A. I do not remember at any time on, or previous to these dates, of his having any telephones supplied to him of any one's make until long after the earliest date of these exhibits. I don't know of any telephone of that kind that was supplied to Mr. Edison.

106 Q. Do you know who made the instrument shown on Exhibit 188-12, No. 1?

A. I believe some parts of it were made by myself.

107 Q. Do you know whether any one else was working in Mr. Edison's shop at that time besides Mr. Adams and yourself?

A. Yes, sir; John Kresi.

107½ Q. Do you know whether any changes were made in the instrument represented upon Exhibit 188-12, and if you, what?

755 A. Yes, sir; numerous changes were made. The spring being changed a number of times for lighter or heavier springs. I believe Mr. Kresi made these springs and they were afterwards put in the cups and tried.

108 Q. What object was there in making these changes?

A. The object was to alter the inertia of the weight in the cup.

109 Q. And where these instruments all tested with the different springs you have stated, and if so with what result?

A. I believe they were; they all worked. They were

all good speaking telephones, but I do not remember that there was any remarkable improvement in the changes made in these springs.

110 Q. What period of time was occupied in making these changes, and during what months were they made?
A. They were made during the month of October, 1879, and I believe occupied no more than two weeks.

111 Q. Referring to EXHIBIT 112-11 please state in what manner the parts were adjusted, if at all, so as to adapt them to use?

A. The only adjustment that I remember on this machine was on the large spring, which could be made to press on the diaphragm by moving the post to which it was attached. The end of the spring opposite to the end holding the plumbago was attached to the post. The diaphragm was brought in connection with the small platinum spring which rested against the plumbago cylinder, thus the adjustment of this large spring put more or less pressure on the diaphragm.

112 Q. And when the instrument was in use did the diaphragm and the platinum spring separate by the movement, or were they intended to separate by the movement of the diaphragm when spoken against?

A. I believe it was not Mr. Edison's intention to have them separate at all.

113 Q. To what were the conducting wires connected in this EXHIBIT 112-11?

A. One of them was connected to the small platinum spring and the other to the lens cap holding the plumbago. When I speak of the platinum spring I mean a small lens spring that was coated with platinum for contact with the plumbago.

114 Q. I notice in the plumbago Exhibit cup and carbon 112-11 a groove across the face of the plumbago; do you know what has produced the same?

A. I cannot remember just now the reason why that groove was put in there, or the instrument for which it

was made. It was not there when we tried the experiment, as shown substantially in Exhibit 112-11.

115 Q. Almost how much of the surface of the plumbago was covered by the platinum faced spring of which you have spoken?

A. I cannot say exactly, but I believe almost the whole surface. The edges, however, of the plumbago were leveled a little.

116 Q. In seeking to make a telephone instrument that was adapted to general use, did you ever adopt any measures to ascertain whether or not any of the instruments made for Mr. Edison were liable to injury in use, or were liable to be put out of adjustment?

A. Yes, sir. An instrument that could not be handled by any ordinary person, and that would get easily out of adjustment, however good the talking was from it, was not considered by Mr. Edison to be of great commercial value. Such an instrument as I mention was made from drawings on Exhibit 6-12, and Ex. 102-12, although giving perfect talking was not considered by him to be of such a standard that was requisite to go in uneducated hands. I have known Mr. Edison to frequently drop an instrument on the floor, in order to see if it would lose its adjustment, if so, he would endeavor to devise some further means to prevent this.

117 Q. What has been the result as far as you know of Mr. Edison's prolonged efforts to produce telephone instruments of commercial value, and that were not likely to get out of order when in use. State whether or not any of Mr. Edison's instruments have gone into public use?

A. The result, as far as I know, of Mr. Edison's efforts is the production of the loudest speaking telephone in existence. These telephones have been used largely.

Cross examination by J. J. Sweeney, Esq.

sQ. 118. You say in your testimony in 11th answer, that Mr. Edison borrowed some tuning-forks and Helmholtz

hale resonators. What were those resonators to be used for?

A. They were used at the time by Mr. Edison in quite a number of experiments, but having no record of those experiments I cannot exactly describe them.

Q. 119. Can you tell me what particular function those resonators were intended to perform?

A. I cannot. They were used very early in our experiments.

Q. 120. What were they used for?

A. As far as I remember they were used by Mr. Edison in his experiments to find out how much the resonator increased the volume of sound of the fork when applied to it.

Q. 121. For the purpose of so increasing the volume of sound did he apply any of the resonators indiscriminately to any fork, or did he apply to each fork the resonator of corresponding pitch?

A. He could not apply any resonator to any fork to increase its sound, and do so except with the resonator that was suited for the pitch of that fork. In the particular instruments to which I refer, each fork had its own resonator.

Q. 122. Please look at your 21st answer, and tell me how you fix the date of April 19, 1877.

A. I fix the date April 19th, 1877, from a drawing marked EDISON'S EXHIBIT 57-11, which shows a telephone instrument working on the same principle as the relay shown as Edison's "EXHIBIT INSTRUMENT TELEPHONE RELAY 58-11." The experiment illustrated by this drawing was to be made by myself and Adams, and the drawing has instructions on it from Edison to make it that it works by pressure on the relay principle, so that the relay on this principle must have been tried before.

Q. 123. Is that the only way in which you fix the dates?

A. I do not remember to have seen in these exhibits

the telephone relay, earlier than this date, therefore I cannot fix the date any closer.

Q. 124. Please look at EXHIBIT SKETCH 58-10, April 19, 1877, marked pressure relay, witnessed by you and Mr. Adams and Mr. Edison, and tell me whether there is any sketch or drawing or other exhibit showing the pressure relay before that date.

A. I cannot call to mind at present any sketch of a pressure relay earlier than this date, though I believe it was made earlier than this.

Q. 125. What makes you believe so?

A. It seems to me that we had it working much longer than two months when it was illustrated in the Journal of the Telegraph, June 1st, 1877.

Q. 126. After looking at those two Exhibits 58-11 and 57-11, and observing also the directions on the Exhibit 58-11, do you think it would have been, according to the ordinary practice at the laboratory, for Mr. Edison to have made the rough Sketch 58-11, for the first time, after you had a finished instrument working?

A. The drawings on Exhibit 58-11 illustrate in my mind more how the material should be used between the armature and the magnet than the instrument itself, as there is written on it manganese, black oxide, or other inferior conducting material, may be used, plumbago I believe we used at first, which is a very good conductor.

Q. 127. Do you think that Mr. Edison made all the drawings on 58-11 for the purpose of stating that in an instrument which you already had in use manganese, &c., could be substituted for plumbago?

A. The bottom figure I do not know what he made for; the figure in the top left hand corner, I presume, he meant for the same purpose as the middle figure, as our first instrument, if I remember right, had not a solid piece of the material across both cores.

Q. 128. Please look at the sketch 60-11, and tell me if it is not a drawing of the instrument EDISON'S PRESSURE RELAY?

784 CHARLES BATCHELOR.

A. The drawing, as far as I can judge, is intended for an EDISON PRESSURE RELAY.

sQ. 129. The said drawing bears at the bottom the words, "Del'd Apl 16th," does it not?

A. Yes.

sQ. 130. It bears at the top the mark \$4, does it not. According to the usual practice of marking sketches, does not that indicate that it was delivered April 16th, and that its cost or price was estimated then?

A. If the party's name who put the writing on there was affixed to the drawing, I should say I think so.

sQ. 131. Mr. Adams' name is on the paper, is it not?

A. It is in his own handwriting.

Further examination of this witness is suspended until Dec. 3d, as agreed in open session.

S. L. GRIFFIN,
Notary?

786

LEMON W. SCHRELL.

787

Met pursuant to adjournment, December 9th, 1880.

Further cross-examination waived.

CHAS. BATCHELOR.

LABORATORY OF THOS. A. EDISON,
MEXLO PARK, N. J.

Thursday, Dec. 9, 1880.

LEMON W. SCHRELL, being duly affirmed, deposes and says:

I am 51 years old, reside at Plainfield, N. J., and am of counsel for Thos. A. Edison.

I have been generally familiar with Mr. Edison's efforts to produce a speaking telephone, so far as he has furnished the particulars for events and applications for patents. I have prepared his applications for patents now in interference, either from written descriptions and sketches, or models furnished to me by him, or from his verbal descriptions.

Case 130 was prepared from his verbal descriptions given to me March 26d, 1877. I have in my possession the original sketch made by Mr. Edison when giving to me the particulars for preparing this case, and I here produce a photolithograph of the same, which is here offered in evidence marked "ORDER FOR CASE, No. 130."

Mr. Edison made all the sketches on that order, and explained to me the differences between musical sounds and articulate speech; his explanation was, that during his experiments, conducted through a long period of time, he had discovered that articulate speech was altogether different to music. That musical sounds had, as we well know, a regular rate of vibration; that speech had both a rate of vibration and a volume, and he illustrated his ideas and explanations by two rows of dots, which appear on said Exhibit, "ORDER FOR CASE

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No. 130," the upper row of dots indicating musical tone vibrations, the lower row of dots the greater or less volume of the sounds in articulation, the rate of vibration being the same. Mr. Edison wrote the words "Speaking consists of sounds at one rate of vibration," and explained that a person could speak in one unusual key or another, and that the volume of the respective utterances determined the articulated sounds.

I wrote the date when that order was given on the said exhibit, viz:

"March 23, '77." Also, "T. A. Edison, Asst W. U."

I also wrote at the bottom the words "Electrical contact of variable resistance or intensity of contact."

701 Mr. Edison explained to me the operation of the diaphragm while coming in contact with the adjacent surface and the rise and fall of electrical tension in an electric circuit passing through that diaphragm across the adjacent surface, and between the date of the said order and the 15th day of April, 1877, I prepared the application for the patent case No. 130. Mr. Edison described to me that the surfaces coming in contact might be of different kinds, and he made a volute spiral upon the order, the same being in the left hand upper portion, so as to illustrate that a resistance would be more or less short circuitled by the motion of a diaphragm. The greater the movement of the diaphragm the larger the area of contact and the greater extent of short circuiting operation. He also illustrated to me upon the said sketch the operation of a device similar to the Edison telephone, by which musical sounds could be sent by make and break contact, and pointed out that he desired to prevent the make and break of contact and to employ the rise and fall of electric tension in the circuit without making and breaking contact.

Cross-examination waived.

LEMUEL W. SERRELL.

LABORATORY OF THOS. A. EDISON,
Menlo Park, New Jersey,
Dec. 9th, 1880.

JOHN KRUESI, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., counsel for Edison, as follows:

1Q. Please state your name, age, residence and occupation?

A. John Kruesi; residence, Menlo Park; age, 37; foreman.

2Q. Please examine the various exhibit drawings produced by Mr. Edison in this case and state which, if any, bear your signature, and how you came to sign the same, and at what date?

A. I signed drawings upon request of Mr. Edison. The habit was to sign the sketches the day they were dated. Exhibit 7-9 was signed by me Nov. 16, 1875. I think I helped make the apparatus shown in that exhibit.

I also signed the Exhibit 9-9 on or about Nov. 16, 1875; I remember that the instrument shown on that Exhibit was made and I think I did some of the work upon it.

I signed Exhibit 22-9 about Dec. 20, 1875, and did some of the work on the instrument therein represented; I remember the apparatus shown on Exhibit 71-10 being made—I wrote the date "Dec'd March 21, 1877," upon Exhibit 28-11; the instrument therein shown having been made at the time; this was for a telephone experiment; I recognize Exhibit 41-11; I made the instrument therein shown for twelve dollars, about March 23, 1877; I also identify Exhibit 29-11 as an instrument I made. I think it was a patent office model; I also recognize Exhibit 58-11 and 60-11 as representing pressure relay, which I helped to make; I remember working on the instrument represented on Exhibit 120-11 in 1877; I remember making the device shown on Ex-

707 JOHN KRUESI.

Exhibit 181-11 in 1877; also the device shown on Exhibit 184-11; also the device shown on the upper figure of 183-11; the dates written upon Exhibit 70-12, 73-12, and 74-12, namely "Del'd July 28, 1877;" are in my hand-writing; the Speaking Telephone instruments illustrated by those diagrams were made by me; I made the drawing exhibit 124-12 and the instruments shown on 119-12, 121-12 and 123-12, they being transmitting and receiving instruments; they were made in 1877; I can't tell the date positively from memory, but think it was about August; I recognize 138-12 as a sketch showing a model which I made; this model was delivered August 30, 1877, the date being in my hand-writing;

708 I recognize the drawing 26-13; I made the instrument about October, 1877; I also recognize the sketches 21, 22, and 25-13; I also recognize drawings 23 and 40-13, they represent telephone transmitters, which I helped to make; the instrument shown on Exhibit 36-13 I also helped to make about Oct. 1877; I remember I made some of the devices shown on sketches 102 and 104-13, these were made about Nov. 1877; I also remember making the instrument shown on 149-13, this was made about Nov. 1877. I also remember several other devices being made which are shown in those exhibits besides those that I made.

3 Q. Did you ever make any diaphragm for Mr. Edison, if so what is the first one which you remember?

709 A. I think the first one was sheep skin with iron on it; the second one was all iron.

4 Q. When was the iron one made?

A. As near as I remember in 1875.

5 Q. What makes you remember that iron diaphragm and the date when it was made?

A. We did not have any iron in the place good enough for the purpose, and I went out to get a piece from Hawthorne Bros.

6 Q. Tell us in that connection where their place was?

JOHN KRUESI. 810

A. Their place was near the corner of Market and Ward streets, Newark, N. J., and Mr. Edison's place at that time was 10 and 13 Ward street, Newark. The iron was very much thicker than Mr. Edison wanted it, and I worked it out to the required thickness.

7 Q. What was done with it after you had reduced its thickness?

A. I finished it as a diaphragm, and it was applied to a brass tube. There was an electro-magnet in front of the diaphragm. This electro-magnet was outside the brass tube. The electro-magnet was adjustable so that the cores might be brought nearer to or farther from the iron diaphragm. This was in the early experiments of Mr. Edison, after I had made a number of apparatus which were called acoustic telegraph. Mr. Edison has made use of iron diaphragms since that time on numbers of occasions, and the iron diaphragms are used on some of Mr. Edison's latest telephones. These latest diaphragms are tin diaphragms.

8 Q. State over about what length of time the efforts of Mr. Edison have extended in devising and perfecting his improvements in telephones?

A. As far as I know, from 1875 until 1879. Sometimes fifteen or more persons were at work on these telephones under Mr. Edison's directions; at other times only three of us. The work was kept up almost incessantly during the period named.

9 Q. Do you remember at any time having anything to do with a telephone instrument in which the electrodes were in water, and if so what is your recollection on the subject?

A. I remember that we made a water telephone. I do not recollect it clear enough that I could give a description of it. I think it was in the year 1877, but do not recollect the month.

JOHN KRUESI.

803 Adjourned by consent to the office of L. W. Serrell,
140 Nassau street, New York, Dec. 10th, 10 A. M.
1880.

S. L. G.,

Notary.

STATE OF NEW JERSEY, } ss.
County of Middlesex,

At Menlo Park, in said county, on the 8th, 9th, 10th,
11th, 12th and 13th days of November, and the 9th day
of December, A. D. 1880, before me personally came
the above named Thomas A. Edison, Charles Batchelor,
Lemuel W. Serrell and John Krenn, and made oath sev-
804 erally that the foregoing depositions by them subscribed
contain the truth, the whole truth, and nothing but the
truth. The said depositions are taken at the request of
Thomas A. Edison, at the time and place named in the
notice hereto attached, to be used upon the hearing of
an interference between the claims of the said Edison
and those of A. E. Doherty, Eliza Gray, A. J. Bell, J.
W. McDonough, G. H. Richmond, W. L. Voeckler, J.
H. Irwin and Francis Blake, Jr., before the Commis-
sioner of Patents, on the first day of March, A. D.
1881.

The said Doherty, Gray, Bell, McDonough, G. B.
Richmond, W. D. Voeckler, J. H. Irwin, and F. Blake,
Jr., were duly notified as appears by the original notices
hereto annexed, and attended by their respective coun-
805 sel as follows:—W. D. Baldwin, Esq., for Gray; Col.
Ges. W. Dyer and Mr. F. H. Batts for Messrs. Irwin,
Voeckler, and Richmond; and J. J. Storow, Esq., for
Messrs. Bell and Blake. The said Doherty and Mc-
Donough did not appear, either personally or by coun-
sel.

And I further certify that each of said witnesses were
duly sworn before beginning their depositions, and that
the whole of said testimony was written out by myself
and George T. Plinkney, and subscribed in my pres-

Z. F. WILLER. 806

ence, and that I am not connected by blood or marriage
with either of the parties to these interferences, nor in-
terested directly or indirectly in the matter in contr-
very.

As witness my signature and notarial seal this 17th
day of December, A. D. 1880.

[SEAL.]

S. L. GRIFFIN,

Notary.

OFFICE OF L. W. SERRELL,

140 NASSAU ST., New York, N. Y.

FRIDAY, Dec. 10, 1880. 807

Met pursuant to adjournment.

Present—Counsel as before.

Z. F. WILLER, being duly sworn, deposes and says in
answer to interrogatories proposed by L. W. Serrell,
Esq., as follows:

1Q. Please state your name, age, residence and occu-
pation?

A. My name is Z. F. Willer, age 39 years, occupation
Patent Solicitor and Lawyer, residence New York,
N. Y.

2Q. In what position were you or what business in the
year 1875?

A. I was principal examiner in charge of the class of
mathematics and philosophical apparatus in the United
States Patent Office.

3Q. Do you know Thomas A. Edison, if so, when
first?

A. I have known Thomas A. Edison, since about
1871.

4Q. Did you ever visit his place in Newark, if so
about when?

800 Z. F. WILDER.

A. I have made several visits to his place in Newark, the exact dates of which I do not remember, but from attendant circumstances I fix two visits as being in 1875.

5Q. Did any conversation pass between Mr. Edison and yourself at either of those visits in relation to any patents of his already granted upon electrical devices, and if so, what was said?

A. At one of these visits allusion was made to the subject of what may be termed harmonic telegraphy, when Mr. Edison in substance asked me if I remembered his water relay patent, meaning by that to indicate a patent which had been granted to him wherein
810 the moving contact played in water.

The patent is here present and is number 141,777, dated August 12, 1873.

Upon my responding as I did he said that if a diaphragm were put upon it to cause the movement of the contact it would make a talking telephone which is the substance of the conversation upon this patent.

Answer objected to by Mr. Baldwin as hearsay and as inconsistent with the preliminary statements.

Counsel for Edison refers to preliminary statement of Edison in this interference, in which he places the conception of the particular feature as about July, 1875.
811

6 Q. At that conversation was any reference made to any devices before proposed or constructed by any other parties or to any publication relating to the subject of your discussion; if so, what was said?

A. I do not remember that any such reference was made; my impression is, not.

7 Q. Can you state what led to this conversation between Mr. Edison and yourself?

Z. F. WILDER.

812

A. There had been some conversation about transmission of musical notes or tones by electricity and its adaptability for telegraphic purposes, which led to the statements concerning a speaking telephone, which I have recited.

8 Q. Previous to your visits to Newark, in 1875, had you or not been familiar with musical telegraphs or the transmission of musical sounds?

A. I had acquired some knowledge from applications filed in the Patent Office, which passed through my hands for examination.

9 Q. Previous to the conversation with Mr. Edison, of which you have spoken, when, as you say, he spoke of using a diaphragm in connection with the devices shown in his patent 141,777, had you or not known of any instance where it was proposed to transmit articulate speech electrically?

A. The only information which I had was derived from such meagre account as I had seen of Reis' experiments.
813

10 Q. Was there anything, if so what, that impressed this conversation with Mr. Edison upon your mind?

A. The fact that it was the first suggestion which I had heard or knew of from any American inventor as to a speaking telephone impressed me.

11 Q. Are you able to define what time in the year 1875 it was when this conversation took place?

A. I made visits in the late spring, and in the late summer or early fall of 1875, to Edison at Newark, New Jersey, but at which of these visits the conversation occurred I am not able to state. The suggestion which we made, rather than the date of making it was the matter which impressed me.
814

12 Q. Did Mr. Edison or not make for you any sketches at the time of this conversation?

A. No, sir.

815 JONAH C. REIFF.

13 Q. From the conversation on the subject did you or not understand what Mr. Edison desired to accomplish?

Objected to by Mr. Baldwin, as incompetent.

A. I understood from the conversation that he thought he could make an arrangement which would transmit speech electrically.

Cross-examination:

By W. D. BARNETT, Esq.,

816 14 xQ. Please explain your present relation with Thomas A. Edison?

A. I am in charge of some of his patent matters, but as a patent agent am opposed to him in telephonic matters. Our firm is retained in all matters excepting those relating to telephones and the quadruplex controversy.

Z. F. WILSON.

Office of L. W. SEARLES,
140 Nassau St., New York, N. Y.
Friday, December 10th, 1880.

817 JONAH C. REIFF, being duly sworn, deposes and says in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Please state name, age, residence and occupation?
A. My name, Jonah C. Reiff. I am 42 years old, and reside in New York City, and President American Automatic Telegraph Co.

2 Q. Do you know Thomas A. Edison?

A. I do; I have known him since latter part of 1870, and have associated with him.

JONAH C. REIFF. 818

3 Q. Did you ever visit his place in Newark?

A. Yes, frequently, between 1870, and the winter of 1875-1876, up to the time of his removal to Menlo Park.

4 Q. Did you know anything about any instruments made by Mr. Edison for telegraphing in connection with sound, sometimes called musical or acoustic telegraphs?

A. I did.

5 Q. When first; where and what did you know?

A. In regard to his experiments in what is called acoustic telegraphy, I know that he was experimenting continuously after the latter part of the summer of 1875, at the Ward street shop in Newark, New Jersey, up to the time of his removal to Menlo Park. Mr. Edison was experimenting to determine the practicability of acoustic telegraphy, as it had been developed by Mr. Gray of Chicago. He used a complicated mechanism composed of tuning-forks, telegraph keys and sounders in connection with what he called his resonators, which consisted of a hollow tube covered with a diaphragm at one end, near which was fixed a magnet. I cannot describe the relation of the several parts of mechanism employed to each other, not being an electrical or mechanical expert. I was present on numerous occasions, mostly at night, frequently remaining in Newark all night at the shop, and noted his attempt to receive the sound of the Morse characters. That is, the resonators held the place in these experiments that the receiving sounder holds in ordinary Morse telegraphy. Frequently at his request I sent dots and dashes by slowly operating one of the keys; he using me when there was no better material at hand. I remember that most of the characters that I made were dots, because I could not work with sufficient despatch to distinguish the dot and dash characters.

6 Q. Please state about the relative locations of the instruments at Mr. Edison's place?

A. Those that are most impressed upon my mind were, the tuning-fork combination that was placed on a wall,

table in the main shop on the first floor at Newark, and the resonators were in a little room partitioned off in the front part of the shop, so that Mr. Edison could obtain as much quiet as possible in listening to the sounds being received and avoid the mingled noises in the main room of the transmitting apparatus and the voices of the persons present and their moving around. I do not remember the exact date when that partition was set up, but I think it had been there for a considerable period. I saw the resonators in the main room of the shop, but think that I did not see them used as receivers by Mr. Edison, except in the small room. The keys remained, so far as I know, on the large table near the tuning-fork combination. I do not know what Mr. Edison may have done upon occasions, either day or night, when I was not there.

7 Q. Please examine the instruments marked Exhibit A, A', November, 1875, and Edison Exhibit B, November 1875, and state whether or not you ever saw said instruments before, or instruments like them?

A. Exhibits A and A' are either the identical instruments that I saw, or similar ones made after the general plan. They are apparently the instruments that I saw Mr. Edison use at Newark. Exhibit B I do not fully recognize, but do remember that he had more than two of these tubes, and of various sizes. I don't distinctly remember the large horseshoe magnet fixed alongside of the tube of Exhibit B, but do remember that in front of one of the resonators he had a movable plate or bar, similar to the one upon Exhibit B. I do not call to mind that I saw that bar in operation on Exhibit B.

8 Q. Did you see either Exhibit A or A' in use; if so, about when and what was done with them?

A. I saw them, or instruments like them, frequently being used by Mr. Edison, in the little room, as heretofore mentioned.

9 Q. Did you ever yourself examine or listen to either of the instruments A or A', while being made use of at

Mr. Edison's place in Newark, and if so, what sounds, if any, were heard?

A. I listened to those instruments, or instruments like them, and heard the Morse characters, as well as the humming sounds, produced by the operation of the tuning-forks, and frequently the mixture of the voices of those in the outer shop, when they could not be distinguished away from the receiving instruments.

10 Q. Do you or not remember words being heard or articulate sounds on those instruments A or A' or similar ones?

A. I heard the sounds of the human voice and could distinguish the voices from each other; but do not remember that I attempted to distinguish the words themselves. I remember that I could recognize parties outside talking, among whom were Mr. Babelelor, Mr. E. H. Johnson, a man named Adams, formerly an assistant of Mr. Edison's, and any one else who might happen to have been there at the time. A Mr. Spivey was frequently there when I was there, he giving special attention to experimenting with light and sound.

Adjourned to 9½ o'clock A. M., Thursday, December 11, 1880.

G. T. P.,
Notary.

140 NASSAU STREET, NEW YORK,
SATURDAY, Dec 11, 1880.

Met pursuant to adjournment.

Continuation of examination of Mr. J. C. Keiff by L. W. Serrell, Esq., counsel for Mr. Edison.

11 Q. Are we or not to understand from your last answer that upon the instruments Exhibit A and A', or instrument corresponding with them, you were able to distinguish one voice from another, you being in the

||| voice heard —

827 JOSHUA C. REPPF.

small room where the instruments were and the voices in the shop?

A. That is what I meant to say.

12 Q. Have you any recollection as to the reception upon Exhibits A or A', or similar ones, of musical sounds?

A. I think not, except as to the musical sounds that belonged to the vibration of the tuning forks.

13 Q. Do you remember whether or not you were ever present and listened to the instruments A or A' when more than one tuning fork was vibrating at the same time, and whether or not those instruments reproduced electrically compound tones, as well as the simple tone from a single tuning fork?

828 A. I don't know how many tuning forks were in the combination, but there was more than one. Not knowing anything about the science of electricity or sound technically, I can't enter into detail as to the operation, but think I was present on more than one occasion when there were three distinct keys being operated in connection with three receiving instruments similar in character to Exhibits A and A'. As I stated yesterday, I heard the dots and dashes on each of the receiving instruments as well as the sound from the vibrations of the tuning forks and the mixture of voices; but not knowing specifically how the receiving instruments were related to the respective keys, I cannot tell by which key the dots and dashes were respectively made and they were the particular sounds being experimented with.

829 14 Q. State whether or not you saw any wires or connections between the exhibits A and A' or similar instruments, and the tuning fork combinations and keys?

A. I think the wires were run upward from the tuning fork combination toward the ceiling, and then across into the little room where the receiving instruments were installed, but how they were connected, I don't know; I know there were wires connected with the tuning fork and with the instruments, exhibits A and A', or those like them.

JOSHUA C. REPPF. 830

15 Q. Is there any circumstances which enables you to define the time when the instruments, exhibits A and A', or similar ones, were listened to by you?

A. I was in Newark frequently during the summer, fall and winter of 1875. My impression is strong that I saw these instruments before it was cold enough to wear my overcoat in my trips to Newark. I think if I had time to look over my letter book and other memoranda relating to subjects affecting that period, that I might with more definiteness fix a date. This circumstance is, in my mind, that whilst these experiments were going on, we used to leave the shop from about P. M. to one A. M., and go up to a restaurant, I think on Market street, to get what we called supper, and I do not remember that any of the party were overcoats.

831 Commed for Gray objects to any testimony tending to anticipate the date set up in Edison's preliminary statement or any testimony inconsistent therewith.

Cross-examination by Wm. D. Baldwin, Esq.:

16 Q. Referring to your 9th and 10th answers, was the mixture of the voices of those in the outer shop which you could distinguish transmitted in the key of the tuning forks, or did they possess independent tones of their own?

A. I don't know how they got there; simply know that I heard them in the instrument.

17 Q. Do you mean to be understood in your last answer as saying that the sound of the voices which you say that you could distinguish were transmitted electrically, telephonically or telegraphically through the wire?

A. I don't know.

18 Q. Were the sounds of the voices apparently those of ordinary conversation taking place in the room with the transmitting instruments?

832

*Voices heard
dots & dashes*

A. Sometimes they were the tones from ordinary conversation, louder than they would be in a quiet room, on account of the noises connected with the operation of the various machinery, and the movements of the men, and sometimes of lower tones when Edison told them to make less noise.

19 xQ. How did he tell them to make less noise?

A. Sometimes called loudly to them himself, sometimes, when I was in the little room with him, he would ask me to tell them, when I would open the door and do so.

20 xQ. What was the distance between the receiving and the transmitting instruments at the time you have mentioned?

834 A. Roughly I should say 12 or 15 feet; it may have been more or less.

21 xQ. What kind of partition separated the main shop from the little room?

A. Part wood, and I think part glass.

22 xQ. Could you hear the noise of the machinery in the main shop on the receiving instruments as well as the sound of the voices?

A. I have so stated.

By the machinery I meant principally the mechanism in connection with the turning forks.

23 xQ. My question referred to the noise caused by engine, gearing, belting and working tools of the shop, not to the turning forks. Please answer it in that view.

836 A. As a rule at that time, I think the general machinery of the shop was not running late at night when I was there.

24 xQ. Was it running at any time when you were experimenting with these instruments?

A. I cannot state positively.

25 xQ. Did the fact of being able to distinguish voices strike you as being anything extraordinary at the time?

A. It seemed to me a singular fact.

26 xQ. Did you make any investigations or experiments to investigate this singular fact beyond listening at the receiver?

A. No; for the reason that I am neither a scientist, electrician, mechanic nor experimenter.

27 xQ. What relation existed at the time of these experiments between Edison and yourself, which caused you to be at his shop so frequently and so late at night?

A. I had been in business relations with Mr. Edison since 1870, and was very much interested in his experiments of every kind.

28 xQ. Does that business relation still continue?

A. A business relation still continues.

29 xQ. Does that business relation involve any pecuniary interest on your part in any of Mr. Edison's electrical inventions or applications?

A. It does.

Cross-examination by Col. G. W. Dyer:

30 xQ. When did you first know about telephones?

A. Strictly speaking in relation to the transmission of articulate speech by a telegraph wire, I think it was at the Centennial Exhibition, when Bell exhibited what he called a curiosity which he said he did not comprehend, I heard Mr. Bell say that.

31 xQ. Was that the first time that you ever heard about telephones?

838 A. That was not the first time that I heard of the use of the word telephone. My previous answer covers the case as related to the transmission of articulate speech, as far as I now remember. I think I wrote a letter to a friend some time in 1875, in which I referred to a California party in connection with a new telegraph scheme, and stated that it was reported he had had under his control a telephone.

32 xQ. When you visited Mr. Edison so frequently at Newark in the late summer and fall of 1875, and winter of 1875-76, did you suppose that you had of pecuniary

interest in the inventions in which he was experimenting during that period of time?

Objected to by counsel for Edison, as irrelevant and not properly of cross examination.

A. I do not consider that to be a proper question, as in my judgment it cannot affect the subject matter involved in this interference, unless it shall be attempted to lessen the force of my testimony upon the ground that a personal interest might influence my statement under oath. As I have previously stated, not being an expert in any sense, I never went into the consideration of Mr. Edison's experiments, beyond noticing the results, or the means by which those results were accomplished, in the most general manner possible.

Q. To prevent any misunderstanding as to the reason of the preceding question, I state that the object was to learn from you whether the attention you gave to the experiments about which you have testified was the attention which proceeded simply from curiosity or from a present or proposed pecuniary interest?

Counsel for Edison objects to the question upon the grounds that the Patent Office has declared an interference to determine the priority of right, and that the question of ownership does not enter into the contest; that even suppose the witness might have considered himself to be pecuniarily interested, which in some matter of business he was with Mr. Edison, still he is entitled to give his evidence in this case.

A. I understand the obligation of an oath, and propose to answer the questions submitted to me, as to facts

of which I am cognizant, in view of the obligation of that oath, but I do not believe I am called upon to disclose my business relations with Mr. Edison that are not involved in this interference.

Q. I did not ask as to the question of property, but as to the quality of examination which you gave to the experiments about which you have testified, whether it was an examination which proceeded from idle curiosity or otherwise?

A. I have stated that I noted certain results obtained on the receiving instruments; I have stated that I did not know how those results were produced; except that I believe the sounds of the dots and dashes received proceeded from the motions communicated to the transmitting keys by the persons operating them.

Q. Is that all the answer you propose to make to that question?

A. I might say that so far as a non-expert can, I endeavored to notice the cause and effect with the same intelligence that I would bring to viewing any object of interest. I do not understand that an intelligent person is to be charged with idle curiosity, unless he first positively states that he has a personal pecuniary interest in the object seen or subject discussed.

Q. Counsel for Edison having stated that you were pecuniarily interested in some matters of business with Mr. Edison, and put this statement upon the record without objection from you, will you now kindly state whether or not the inventions covered by the experiments about which you have testified, included matters in which you were pecuniarily interested with Mr. Edison?

Counsel for Mr. Edison objects to this question on the grounds that it substantially raises an issue in this case corresponding to what has been faultily known as the "title fight" in the quadruplex

suit between the Atlantic and Pacific Tel. Co. claiming to hold under assignment from Edison to Mr. Harrington, in behalf of himself and the witness (Mr. Edli) and the Western Union Tel. Co., Geo. B. Prescott and others, and that some legal proceedings growing out of this question of transfer are still in progress, and that the witness cannot properly be required to answer any question that might interfere with any claim he might be entitled to set up in the premises, he not having been called in this interference upon any such point, and that he is privileged to decline to answer any such question if he sees fit.

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A. I do not understand that I am to be bound by any statement the counsel for Mr. Edison in this interference shall make, whether it relates to his opinion, to his knowledge, or to the language in which he catches the statement which he chooses to put upon the record, and I therefore consider that I have already answered the substance of that question fully and truthfully in my answers to x-questions 32, 33, 34 and 35.

37&4. Is that all the answer you are willing to make to the preceding question?

A. Yes, sir.

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Further cross-examination declined by Col. Dyer, on the ground of non-answering these questions, and notice is given that at the time of hearing, motion will be made to suppress this deposition.

The witness says:

I desire to add in reference to that portion of my testimony connected with 32 x question and 37 x question inclusive, that as I understand the matter, the only ques-

tion at issue in this interference is as to the priority of invention and not as to ownership.

When any proper occasion arises, and before such a tribunal as makes it pertinent thereto, I am perfectly willing to be questioned as to my business relations with Mr. Edison.

I am unwilling to be placed on the record as seeming to decline to answer freely any proper question without protesting against the injustice of the intimation.

Cross-examination waived by counsel for Bell & Blake.

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JOSIAH C. REIFF.

OFFICE OF L. W. SEIBELL,
140 Nassau st., New York, N. Y.,
Saturday, Dec. 11th, 1890.

EDWARD H. JOHNSON being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Seibell, Esq., counsel for Mr. Edison, as follows:

1 Q. Please state your name, age, residence and occupation.

A. Edward H. Johnson, age 34 years, residence New York, N. Y., occupation electrical engineer.

2 Q. Please examine Exhibits A and A', and state whether you ever saw the same, and if so, when and where, and what, if anything, was done with them?

A. I saw the instruments, Exhibits A and A', at the time they were made in the laboratory of Mr. Edison, at Newark, N. J., in the fall of 1875. They were used by Mr. Edison to analyze the sounds which were transmitted over a wire by means of reeds, telegraph keys and other devices. I was at that time visiting the laboratory almost nightly, and frequently assisted Mr. Edison in his experiments with these instruments in my

*No objection
of this class
hearing*

capacity as a Morse operator, by listening to the sounds emitted by them and translating the messages transmitted from the other end.

The object of the experiments was to transmit a constant tone, or rather a series of them, and by interrupting each tone with a Morse key, to throw it into dots and dashes of the telegraph.

Various forms of these receivers were used in the effort to find one which would only respond to a given tone. The present form which constitutes these exhibits, I remember, were objectionable, because they responded not only all the tones of the transmitting reeds, but also the false or foreign sounds due to an interference once with the transmitting instruments.

I remember distinctly having my ears severely condemned by Mr. Edison because of my inability to clearly distinguish the signals or sounds which he desired me to read from those which I was to ignore, he maintaining that I should get but a single tone, and a signal inposed upon it while in fact I not only got this, but every other sound effected by the transmitting instrument.

Q. Please state where these instruments, A and A', were located in Mr. Edison's laboratory at Newark when they were there?

A. In a small office room on the ground floor partitioned off from the machinery department. We went in there to listen to these instruments because it was the quiet. The keys were in the machinery hall, on the same floor. By keys I mean the various transmitting devices used.

Q. State what caused the instruments A. or A' to give out any sound?

A. The currents which were transmitted from the distant station passed through and actuated the electro-magnets which attracting and releasing the iron-disk across the end of the brass tube with great rapidity caused it to emit a sound.

Q. You speak in your last answer of the distant station, what did you refer to and how distant was it?

A. That is a term I always use when speaking of the end of the wire from which the signal is sent, whether it be a few feet or several hundred miles, in this instance the geographical distance was but a few feet, while the electrical distance that is the resistance of the line was constantly varied by Mr. Edison's interposing a greater or less resistance in the line through which the experimentation was made.

Q. Over about what period of time did the experiments with Exhibits A and A' continue, and state whether or not other instruments were made and tested of this same character?

A. The particular instruments which constitute these Exhibits A and A', were used I am quite sure for some two or three weeks, but other forms upon the same principle were being constantly tried. I remember Mr. Edison giving instructions to his foreman almost every night to arrange them in some new way. The general device of combination of a magnet, a disk and a tube were from this time, down to the public introduction of the telephone constantly used as receiving instruments.

Q. In relation to Mr. Edison's experiments for transmitting sound electrically state what character of transmitting devices were employed from time to time and what character of circuits?

A. Principally vibrating reeds, Morse keys, and vibrating electro-magnets. These in turn were arranged in hundreds of ways to produce sometimes a clear break of the circuit and at other times a variation of its resistance while preserving its continuity. Sometimes to effect a variation of the electrical tension by the introduction of more or less battery. Mr. Edison would make as many as a hundred different connections in one night, some of which yielding no satisfactory result I would not see while others which seemed to him to be fruitful, he would call me to witness. I remember remarking at the time that the best results upon the receiver seemed to be

all but results all sounds

all sounds received

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obtained when the greatest number of transmitter instruments were used.

8 Q. Have you been generously familiar with Mr. Edison's experiments and tests resulting in the production of a carbon telephone. If so, state what character of circuit has been availed of and what devices have been introduced in that circuit to operate in the transmission of the electric pulsations?

A. Yes, sir. Mr. Edison's experiments to effect a variation of resistance of a circuit by means of a greater or less intensity of contact or degree of pressure of a conductor or semi-conductor soon developed the fact that so small a variation could be effected as to make it 888 greatly disproportionate to the resistance of an ordinary line, such as it would have to encounter in practice. He therefore placed this variable resistance device in the primary circuit of an induction coil, the total resistance of which would not exceed one ohm. Under those conditions of proportionate resistance of that part of the circuit composed of the transmitter, the maximum result in the variation of resistance effected was attained; the carbon transmitter finally adopted by Mr. Edison, and which was the direct outgrowth of those early experiments, composed of a carbon button 1-2 inch in diameter and 1-8 of an inch thick, approximately, mounted from lamp black and placed between two metallic surfaces, the whole constituting part of an electric circuit.

89 Q. About when were instruments such as referred to in your last answer put into public use, and where?

A. I don't remember the exact date; my memory is exceedingly poor on dates; I never charge my mind with dates. I remember distinctly paying frequent visits, sometimes in company with Mr. Edison and sometimes alone, to Mr. Orton, then President of the Western Union Telegraph Company, for the purpose of showing him a carbon transmitter in practical operation. We tried the instruments at various times and on various circuits in the rooms of the Western Union Telegraph

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Company, and on one occasion between that office and the residence of Mr. Orton, in New York. This was some considerable time prior to the signing of the contract between Mr. Edison and the Western Union Company for his telephone inventions. I think as much as seven or eight months; I refer to the contract dated May 21st, 1878. In 1877 I was lecturing upon the subject of Mr. Edison's telephone work, and used in those lectures a device which transmitted only the tones, and not articulated words. I remember, in this connection, constantly beseeching Mr. Edison to allow me to use his carbon transmitter, saying that my public exhibit would be so much more effective if I could reproduce to the audience articulated words such as I heard from time to time in his laboratory. His objection to doing so was, that the reproduction would not be sufficiently loud to enable an audience as one body to hear it. There was a lecture delivered at the Centennial buildings, in West Philadelphia, by Prof. Geo. F. Barker, some time in July, 1877; I being present, and operated the instrument. We find at that time a Reiss transmitter and Edison electromagnetograph recorder. I gave lectures myself from this time onward to October 18th, with few days intermission. The notice of one of these lectures has been introduced as an exhibit in this case, being the notice of the exhibit at Twentieth Hall, at Albany, on Sept. 25th, 1877, gives the substance of the lectures delivered by me. I gave a lecture on Oct. 18th, 1877, at the Tabernacle, Jersey City, the programme of which and notices have already been put in evidence, and at this lecture the Edison carbon transmitters were used, and articulate speech transmitted and reproduced in the hall, Mr. Edison himself speaking and singing through the transmitting instruments, which were located in the office of the Western Union Tel. Co., in the Pennsylvania

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nia R. R. depot, and at this time these carbon telephones were publicly used for purpose of profit.

Examination adjourned to Tuesday, Jan. 4th, 1881, at 10 o'clock A. M.

GEO. T. PINKNEY,
Notary.

OFFICE OF L. W. SERRILL,
140 Nassau street,
New York, N. Y.,
January 4, 1881.

Met pursuant to adjournment.

Present—L. W. Serrill, Esq., on behalf of Mr. Edison. Col. George W. Dyer, and Mr. Butts, of Messrs. Betts, Attorney & Butts, on behalf of Moore, Irwin, Venker & Richmond, and W. D. Baldwin, Esq., on behalf of Mr. Gray.

Continuation of examination of Mr. E. H. JOHNSON by L. W. Serrill, Esq., Counsel for Mr. Edison.

10 Q. Please state what transmitting instruments were used at the W. U. Tel. office in the R. R. Depot at Jersey City, and how you obtained your knowledge this way?

A. They were the Edison Carbon Transmitters in their then existing form, but precisely what that form was I cannot now recall. They were enclosed in a wooden case, and effected a variation of the current by variation of the pressure of the diaphragm upon a button composed of plumbago and a fibrous material. I connected these instruments at the telegraph office for operation during this lecture, myself before going to the

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lecture hall. Mr. Edison afterwards operated them for me. Mr. Edison, Mr. Batchebor and myself brought the instruments from Menlo Park for this purpose.

11 Q. What kind of receiving instrument was used at the Tellerets on this occasion?

A. We used two kinds; one for ordinary conversation, and one for so increasing the volume of sound as to make the words audible to the entire audience. The first was the magnetic receiver, consisting of magnet, helix and diaphragm. The other was the electromagnet, consisting of sounding board, small drum roller and strip of chemically prepared paper. By means of the latter described instrument, the articulated words were made sufficiently loud and distinct to be heard throughout the hall; this is due to the fact that a greater amplitude of vibration of the diaphragm can be effected with a given strength of current by an instrument having this operative principle, than by any form in which the magneto principle can be used. To make this clear, I will explain that in the magneto the current attracts and releases the diaphragm by reason of the variation in the strength of the magnet affected by the electrical current passing through the helix surrounding the magnet. As these electrical currents are necessarily very feeble it follows the variation in the strength of the magnet, and the consequent amplitude of vibration of the diaphragm is proportionately small. In the electromagnet receiver, the principle is supposed to be one of difference of friction, the operation being as follows: A small roller with crank attachment is placed in a position on a line immediately in front and a few inches from the central face of a sounding board or diaphragm which may be of any size from that of an ordinary telephone receiver to that of a piano; attached to the centre of the sounding board at one end, and with the other resting upon a small roller is a rigid piece of metal which is made to bear with a considerable pressure upon the roller by means of a spring suitably placed. The strip of chemically prepared paper is made to pass between

the face of the roller and the end of this metal attachment of the sounding board. Electrostatic connections are so made as to cause the current to traverse the roller, the chemical paper, and the metal bar. If now the crank is rotated, outward from the sounding board while no current is passing, the very considerable friction between the paper (carried forward by the roller) and the end of the metal bar, drags the sounding board outward toward the roller precisely as if it were attracted by a very powerful magnet, its release from this position (the forward movement of the drum being continuous) is effected by the passage of an electrical current, which current affects, by lubrication, or otherwise, a decrease of the friction between the paper and the bar. The degree of this lubrication is directly proportionate to the strength of the current, it will thus be seen that if a current of varying strength passes through the device a variable friction will be had on the surface of the paper, and a consequent variation in the degree of amplitude of the sounding board vibration. Mr. Edison has subsequently incorporated this principle in what he terms his "sound speaking telephone," such as the Exhibit introduced in this case, marked "Edison's Exhibit Motosphone" (Electromagnetograph). Many thousands of these are now in use. The sounding board used at this entertainment was about 2 foot 6 inches in length, 18 inches in width, and 1-2 inch thick, with the roller and chemically prepared paper as above described.

12 Q. Please look at the programme and handbill of the entertainment at the Tabernacle, Jersey City, October 18, 1877, referred to in the testimony of Charles Batchelor, and marked E, and state whether or not they are some of the originals?

A. Yes, sir; they are.

13 Q. Please state in which part of the programme the carbon telephone was used, and whether or not words were received and reproduced upon the electromagnetograph, of which you have spoken?

A. No. 7 of part 2 in the programme, entitled "Vocal music, from the local telegraph office, by the speaking telephone." This is distinguished from the other parts of the telephone concert by the fact that in this part the words were articulated both in song and in recitation, while in the other parts only the tone was rendered, the transmitting station from which such tone originated being, in this case, from Philadelphia.

14 Q. To what extent was the articulation distinct in either song or recitation at this exhibition?

A. It varied considerably, owing in part to imperfect adjustment of the instruments, and, in part, to our ignorance of the requirements of the chemically prepared paper used in the receiver, that is, to the degree of moisture requisite in the paper to obtain the maximum result; at times the words were sufficiently loud and clear to be easily heard and recognized by every member of the audience, at other times they were only audible to those in the immediate vicinity of the instruments. This foregoing statement refers to the electro-magnetograph receiver. When the magneto receiver was used the words were always intelligible, but only audible to the individual ear of the person holding the instrument, and, therefore, of no service in entertaining an audience, sitting as a body. I do not now recollect whether or not any member of the audience came to the platform to listen to the magneto receiver, but one of the opinion they did, since it was my invariable custom to invite them to do so at the close of the entertainment, which invitation was generally accepted by about nine-tenths of the audience.

15 Q. Please look at the exhibit instruments introduced in this case, and state whether or not any of them correspond generally to the carbon transmitter made use of on October 18, 1877?

A. They were instruments of the general form of the exhibit marked "Edison's Articulating Transmitter, October, 1877," in which was combined a wooden case, diaphragm, carbon button and adjusting screw, *precisely*

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how these several parts were arranged, I do not now recollect. The magneto receiver was enclosed in a similar wooden case.

10 Q. Did you know anything concerning the proceedings between Mr. Edison and Mr. Orton in relation to telephones, if so, what did you have to do with the same?

A. I was familiar with Mr. Edison's efforts to enlist the interest of the electrical department of the Western Union Telegraph Company in his telephone audaciously to give it a trial, and remember that he failed to do so, owing to the personal antagonism at that time existing between him and the various members of that department, until after many weeks, when by direct order of the President, Mr. Orton, a trial was obtained; from this time onward, until the final sale to the Western Union Company, Mr. Edison, Mr. Batchelor and myself were constantly passing to and fro between the laboratory at Menlo Park and Mr. Orton's office, for the purpose of showing him the step by step improvements as they were made. I remember having more than one conversation with Mr. Orton, in which I strongly protested against the evident determination of his electricians, not to give Mr. Edison's instrument a fair trial. Such trial was only finally had by Mr. Orton saying "it must be."

17 Q. What, if any instruments, did you take to Mr. Orton yourself, and state generally what passed with him?

A. I do not now recollect the particular devices or forms of instruments, they were so constantly changing at that time. My conversations with Mr. Orton were mainly in the direction of convincing him that the Magneto Telephone, as a transmitter, would never be a success, and that the carbon transmitter of Mr. Edison would eventually prove to be the key of the whole telephone business, and also to urging him to take the matter personally in hand, as we had no confidence in being accorded proper trial facilities by his electricians. Mr.

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Orton always expressed by assent or otherwise his sympathy with my views, and his determination to give Mr. Edison the opportunity he asked, and ultimately did so. These interviews with Mr. Orton were, of course, before the contract between Mr. Edison and the Western Union was made, as they led directly to it. I refer to the telephone contract of May 31, 1878.

18 Q. State upon what your opinion was based, that you expressed to Mr. Orton, of a preference of the carbon telephone over the magneto?

A. Upon my conviction that the strength of the current which could be generated by such device of a magnet and a diaphragm was limited to the mechanical power of the human voice, from which I concluded that the limit of the capacity of the magneto for current generating was reached, and that the telephone transmitter of the future would be one in which the current was generated as in the ordinary telegraph, in a battery, and simply controlled by the transmitting device; that is to say, by the voice acting on such transmitting device.

19 Q. I produce a small book, called "The Telephone Hand-Book," and ask you if you know anything about it?

A. Yes, sir; I wrote it. It was printed in the year 1877, some time between October 20 and the end of the year.

20 Q. Was any publication made that referred to the concert at the Tabernacle, October 18th, 1877?

A. Yes, sir; in the Jersey City Journal of October 20, 1877, a statement is made which is copied in the last insert of "The Telephone Hand-Book."

The said book is offered in evidence by counsel for Edison, and marked "Johnson's Telephone Hand-Book."

Adjourned for one hour.

G. T. P.,
Notary.

Examination continued.

Cross-Examination by Col. G. W. Dyer:

21 xQ. Was the Reiss transmitter spoken of by you in your ninth answer made in accordance with the description and drawings published in Prescott's book on speaking telephones, and if so, which one of the transmitters described and illustrated in this book?

881 A. It was practically the same as page 13, Prescott's book. The contact points were arranged centrally, in front of the diaphragm; one attached to an adjustable screw and the other to the diaphragm itself. They usually had an elastic substance intervening between the right adjustable screw and the contact point which it carried, as to form a species of buffer, the object of which was to insure freedom of diaphragm vibration.

22 xQ. Referring to your 10th answer, was the transmitter with the button composed of plumbago and fibrous material, which you used in your exhibition at Jersey City, used by you in any other exhibition?

A. I do not recall any other in which it was used.

23 xQ. Was that form of button of plumbago and fibrous material described by Mr. Edison?

882 A. That particular form of button in which carbon was mixed with a fibrous material was eventually discarded for one composed wholly of carbon, but which possessed the same elastic property sought to be obtained in the fiber and plumbago combination, viz.: a button molded from lamp black.

Cross-questions by W. D. Baldwin, Esq., counsel for Mr. Gray:

24 xQ. What are your present relations with Thomas A. Edison?

A. I am associated with Mr. Edison in the laboratory for the purpose of assisting him in the development and introduction of his electric light. I am not in his employ, nor am I in the receipt of a salary. I have no pec-

uniary interest in any of Mr. Edison's inventions so far as the United States is concerned, with the exception of his electric light. I have an interest in his telephone in England, obtained by contract jointly with Mr. Edison and the English capitalists as consideration for one year's service in England.

25 xQ. As a rule, are not Mr. Edison's associates and employees at Menlo Park interested in a manner similar to yourself in his inventions?

A. Not as a rule. The exceptions are, those who have been associated with him for many years, and who do not receive from him a regular salary, but receive instead stock, or other evidence of interest in his inventions. These are Mr. Charles Batchelor, Mr. Francis R. Upton, Major Frank McLaughlin and myself. As a matter of fact I am personally not interested with Mr. Edison peculiarly in any of his inventions with the one exception of the electric light.

Cross-examination by J. J. Srosmow, Esq., Counsel for Bell.

It is admitted by Counsel for Edison that the witness Johnson wrote, and in 1879 printed "STATEMENT as to the ORIGIN AND DEVELOPMENT of the TELEPHONE" from which pamphlet the following extracts are made, and are put in evidence by Counsel for Bell.

884 "As is above indicated we find A. Graham Bell, of Boston, Mass., U. S. A., not only working upon the problem simultaneously with Gray, but anticipating him in the belief that its solution was practicable, and as a natural consequence of the more persistent investigation, evolving in advance of Gray and other competitors, the practical device, thus becoming the true inventor of the apparatus for the transmission of speech. "While Bell, however, was thus at work, another inventor, Thomas A. Edison, of Menlo Park, N. J., U. S. A., whose attention had been called to the subject of

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"acoustic telegraphy by the Hon. William Orton, then President of the Western Union Telegraph Company, had already contributed largely to the science of electrical acoustics, and taking up the subject of the transmission of articulate speech, immediately after Bell's announcement of his achievement, and before he had yet made his device of practical value, soon distanced even Bell himself in the brilliancy of his discoveries, and in the practical application of the invention to the requirements of commerce."

"Edison has always fully and freely acknowledged Bell as the original inventor of the magnetic telephone, while claiming the right to use this apparatus in the United States as a telephone receiver."

887 "He has, consequently, used it for such purpose in connection with his carbon transmitter."

Further cross-examination waived by Counsel for Bell and Blake.

Counsel for T. A. Edison puts in evidence the following extract from the same pamphlet.

"It is noteworthy that Bell by this application of the magnetic principle obtained at once."

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- "1. The combination of a transmitting and receiving instrument in one.
 - "2. The most advantageous arrangement of the several working parts possible.
 - "3. The simplest form of apparatus conceivable.
 - "4. The theoretically perfect Telephone.

"These features constitute at once the glory of the invention and its weakness. It seldom happens that the

E. H. JOHNSON.

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"theoretically perfect device is the practical one, or that a specific apparatus is equally effective for two diametrically opposite purposes."

"It has not happened in this case. In practice it has been found that the currents generated are too feeble to effect either a sufficient physical effect upon the receiver to render the sounds clearly audible, or to traverse any considerable length of line."

"Thousand of pounds have been expended and an extraordinary amount of experimental investigation has been made in the futile effort to increase the strength of these currents, the fact being, as above indicated, that the apparatus as originally arranged by Bell possessed all the virtues there was in the principle. The disturbances of the magnetic force in the transmitting instrument being offset by the power of the human voice, is of course limited in its extent by the limit of the vocal powers; hence the impossibility of any material augmentation of the strength of the currents upon this principle."

"This fact has compelled the almost total abandonment of the Magnetic Telephone as a transmitting device, and the substitution therefor of

"EDISON'S TENSION REGULATOR"

"Edison early saw that the magnetic transmitter would amount to the superior effectiveness of one which should simply control an electric current instead of creating it; he therefore gave his whole attention to the discovery of some principle by which he could convert the constant current of a voltaic battery into one of variable tension in harmony with the sound wave."

It is agreed that a copy of the pamphlet complete shall be sent to the Patent Office in this case.

EDWARD H. JOHNSON.

140 NASSAU ST., NEW YORK, N. Y., }
Tuesday, Jan. 11, 1881. }

Mr. EDWARD H. JOHNSON being recalled, states that he recognizes the instrument, "Prescott's Exhibit Edison's," transmitter, brass tube, with mouth-piece and iron base," and believes it to be the instrument used by him in his lectures for transmitting instrumental and vocal music; that he believes that it is the instrument used by him at Philadelphia, on occasion of the Barker lecture and concert at the Centennial buildings; also subsequently used it at Philadelphia to transmit vocal music to Washington, D. C. That he will produce newspaper accounts of the exhibitions in which said instrument was made use of, to be designated as "Johnson's Washington Exhibition of Telephone."

EDWARD H. JOHNSON.

OFFICE OF L. W. SERRILL,
140 NASSAU street, New York, N. Y., }
Tuesday, Jan. 4, 1881. }

ROBERT SPICE being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrill, Esq., counsel for Mr. Edison, as follows:

894 1 Q. Please state your name, age, residence and occupation?

A. Robert Spice, 35 years of age, 336 Halcy street, Brooklyn, Professor of Chemistry and Natural Philosophy at the Brooklyn High School.

2 Q. Are you acquainted with Thomas A. Edison, one of the parties to these interferences, and if so, when did you first know him?

A. Yes, I first knew him Sept. 14, 1874.

3 Q. Were you ever in his employ, and if so, when and for what duties?

A. Yes; the first time from Sept. 31st, 1874, to Oct. 24, 1874, to give instruction in chemical analysis; the second time from Nov. 20th, 1875, to Jan. 20, 1876, to furnish information in acoustic matters.

4 Q. Have you pursued the study of any particular branch of natural philosophy more than any other, and if so, what particular substance could you render Mr. Edison between Nov. 20th, 1875, and Jan. 20th, 1876?

A. I have worked for many years in the department of sound, especially with reference to sympathetic resonance, and in this particular branch gave aid to Mr. Edison.

5 Q. Did you visit Mr. Edison's place at Newark, and if so, about how often during Nov. and Dec., 1875, and Jan., 1876. 896

A. It was almost nightly; my engagements called me there at night, and during the time of my engagement with Mr. Edison I probably missed three or four nights.

6 Q. During this time did you see any instruments in which acoustics and electricity were employed, and if so, state generally what they were?

A. Yes; tuning forks and reeds were employed in connection with electro magnets.

7 Q. In what manner were the reeds and the electro-magnets connected or operated?

A. The electro-magnets were placed outside the prongs of the tuning forks, and the forks were in the same circuit; the same remark applies to the reeds, the reeds being worked sometimes with one electro-magnet and sometimes with two, one on each side.

8 Q. Did you have anything to do with the tuning of any of the reeds or forks employed by Mr. Edison?

A. Yes; I tuned the forks myself, and I aided in the tuning of the reeds.

9 Q. Do you know whether there were any keys or resistances introduced in the electric circuits during the period that you were acting with Mr. Edison?

A. Yes, both keys and resistances.

10 Q. What kind of receiving instruments, if any, were used, and where were they placed?

A. The forks were used, reeds, I think relays, and also there were tubes closed at one end by metal membranes, operated by electro-magnets.

11 Q. Please describe the tubes and their operation a little more fully?

800 A. The tubes were about two inches in diameter, and, perhaps, seven or eight inches long; some were plain tubes, some had an inner tube to slide, in order to change the length; some were open at the opposite end of the magnet; some were closed with a cup and tube, having small rubber hose to lead to the ear. The object of changing the length of the tube was to adjust the air column to reinforce the particular tone of the reed or fork. These instruments were placed for the most part of the time in a kind of office partitioned off from the main shop. It was on the side of the shop towards the railroad. There was an entrance from the street into this office part.

12 Q. Did you ever listen to either of these instruments that were provided with the tube that you have spoken of?

A. Yes; I heard sounds of the reeds or forks, which ever happened to be in circuit, interrupted by the key, of course.

13 Q. What produced these sounds?

903 A. The vibration of the metallic membrane set up by change of magnetism in the electro-magnet.

14 Q. Do you know whether or not Mr. Edison employed a closed circuit or an open circuit?

A. Closed.

15 Q. What, then, produced change in the electrical condition of the electro-magnet?

A. There are some points here that I cannot be very clear about, not being an electrician, but I know that an

open circuit was found not to work, a closed one was adopted, and, I believe, to accomplish this, resistances were put on the line.

16 Q. Did you at any time purchase any material for constructing any of these instruments containing a tube with a metallic membrane at the end and an electro-magnet?

A. Yes.

17 Q. Where, when, and from whom?

A. This date I can only give within a few days. I think it was sometime between the 1st and 20th of December, 1875. I ordered some drawn tubing, two sizes, one to fit in the other. I don't know the man's name, but can tell where he is. He is over Pratt's hardware store, corner Fulton and Cliff streets, New York.

18 Q. Did you obtain these tubes, and were they used?

A. I obtained them and some of them were used.

19 Q. Look at the instruments here present and state whether or not you recognize either of them as the instrument or instruments to which you have referred?

A. I recognize the tube, Exhibit A. I recognize the instruments marked Exhibits A and A', as being the identical instrument or instruments like them. I believe them to be the identical instruments.

20 Q. Referring to the instruments, exhibits A and A', have you any distinct recollection of these instruments, or any like them, being used at Mr. Edison's place, and if so, what kind of sounds were produced by them?

903 A. Yes, I remember them being used; the sounds were musical, and agreed mainly with the reeds or forks, but not always, on account of the instrumental appliances not being brought to perfection.

21 Q. Do you know whether or not the instruments, exhibits A and A', were adapted to and did re-

spond to the variations in the electric current in the circuit passing through the helix of the electro magnet?

Objected to as leading, and as calling for matter as to which the witness has stated himself to be incompetent to testify.

A. Yes they did; my reason is this: I call to mind one of these instruments would respond to a reed or to a fork. The reed and fork being tuned differently, and therefore sending different electric pulsations through the helix.

005 22 Q. Please state whether or not you at any time listened to either of the instruments A or A' when the transmitting device were being operated, and whether or not the instrument A or A' was limited to the reproduction of any one particular sound?

A. I listened; as I stated before the instrument A or A' would respond to reed or fork, and consequently was not limited to any particular tone.

23 Q. Did you ever hear in either the instruments, A or A', any other sounds than the musical sounds, such for instance as the clicking of the keys?

A. Yes. The clicking of the keys were occasionally heard.

24 Q. During about what portion of your engagement with Mr. Edison did you have anything to do with the instruments A or A', or similar ones?

006 A. About the latter half of December, 1875.

25 Q. You speak of getting tubing. State whether or not instruments similar to A or A' had been made before the tubing was obtained by you, or whether the tubing you obtained was for the first instruments?

A. A and A' were made, I think, before I got the tubing. They might have been made some considerable time before; I don't know that. I merely stated in my previous answer when I heard them.

26 Q. How are you able to define the dates that you have given?

A. I have copied them from my journal. I have been in the habit of keeping a journal for fifteen years, and in that I entered most of my business connections. I referred to the journal twice, first on Friday of last week, and again last night, and I extracted from that journal the dates given, which are on a paper for the inspection of the respective counsel if they desire to look at it. The original entries in this journal were made at or about the dates which they bear.

(Witness states that if it is desired by counsel he will produce his journal so that the dates may be examined.)

508

Counsel for Irwin and others requests the journal to be produced.

Cross-examination by Wm. D. Baldwin, Esq., counsel for Mr. Gray:

27 xQ. What kind of information in acoustic matters did you furnish Mr. Edison in the fall of 1875?

A. Special information referred to sympathetic resonance. I was engaged by them as an expert in sound, and to answer any general questions put by Mr. Edison. 28xQ. Please state a little more specifically what you mean by sympathetic resonance, and the kind of information you gave Edison in relation to it?

509

A. By sympathetic resonance, I mean that condition of two bodies capable of vibrating whereby, if one is made to vibrate and the vibrations can directly or indirectly act on the other, it will also vibrate. The condition necessary being that both bodies should have the same vibration period.

29xQ. Do you know the purpose for which Edison wanted this information at that time?

810 ROBERT SPIKE.

A. I know it was for telegraphic purposes, but exactly what I don't know.

308Q. You speak of forks and reeds, state the differences between them?

A. By a fork I mean a turning fork; and by a reed I mean a straight bar.

318Q. Has a reed or fork a definite pitch, or is it capable, without modification, of transmitting or receiving various tones?

A. It has definite pitch, and cannot transmit or receive other than its own pitch, except external force be employed, which I understand you to mean by the term modification.

911 328Q. What do you mean by "plain tubes," in your 11th answer?

A. By plain tubes I mean not telescopic, but having diaphragms and magnets at the end.

338Q. Did those plain tubes act as Helmholtz resonators to reinforce a particular sound, or did they equally reinforce all sounds received?

A. They acted as Helmholtz resonators.

348Q. Was this result modified in any way by the cap and small tube spoken of in your 11th answer, if so, how?

A. The cap and small tube decreased the loudness, but it was not an improvement.

Adjoined to Wednesday, January, 5, 1881, at 10 o'clock A. M.

GEO. T. PINCKNEY,

Notary.

ROBERT SPIKE. 913

140 NASSAU ST., NEW YORK, N. Y.,
Wednesday, Jan. 6th, 1881.

Met pursuant to adjournment.

Counsel present as before.

Continuation of cross-examination of Mr. ROBERT SPIKE:

[The witness produces his journals called for yesterday, for the inspection of counsel, and points out the various entries.]

By Col. G. W. DYER:

35 xQ. Do you know J. C. Reiff?

A. I do not.

36 xQ. At the time you were assisting Mr. Edison in his experiments at Newark, in fall and winter of 1876-77, was your hearing good?

A. Yes.

37 xQ. Hear almost as much as anybody around could?

A. Yes.

Redirect by L. W. SERRELL, Esq.:

38 R-D Q. I read to you xlat. 31 and answer, and ask you whether or not the vibrations of a tuning-fork or reed are likely to be modified in their rate or amplitude of vibration by surrounding circumstances, such as the jarring occasioned by hammering or filing in proximity to the reeds, or the various noises and shouting by men in a manufactory?

A. Yes, they are liable to be changed; the amplitude will be changed, but not the rate; the reason is this: If a sound wave were to strike a reed or fork when approaching the sound wave, the tendency would be to

decrease the amplitude, and if the sound wave struck the reed or fork when they were receding, the tendency would be to increase the amplitude; the same effect would be produced by motions acting upon the reed through the air or in any other manner; in illustration of that point, if two tuning-forks on resonant cases are placed some distance apart, the forks being perfectly in tune, if one is sounded the other will take up the sound and vibrate itself, the extent of the vibration of the second fork will depend on the state of the room where the experiment is made; if perfectly quiet, the maximum vibration will be obtained; if other sounds are present, the amplitude of the responding fork will be less; the decrease would depend largely on the intensity of the external sounds, and partly on the size of the fork; this statement applies to reeds and any bodies that will respond sympathetically.

20 R.D. Q. If three or four reeds or forks were connected in an electric circuit, and that circuit also included the electro-magnet of one of the instruments A or A', and the forks were in a noisy shop, what is your opinion as to the effect that would be produced at the receiving instrument A or A', by the noise in the shop at the same time that the reeds were vibrating?

A. I think that would lead to interruption of sound on A or A', and changes of intensity. I could not say what the effect would be, but I think it would change the sound. It seems to me that what I have stated about reeds or forks in the previous answer would be the same in a shop. That is to say, that the vibrations of the reeds would be either checked or amplified by the sound-waves acting upon them.

Counsel for Mr. Voelker and Irwin and counsel for Mr. Gray having examined the journals produced by this witness, do not desire any further reference to them.

Re-cross :

By Mr. DALLMEIN :

401R.Q. Suppose a vibrating reed, transmitter, or tuning fork to be driven at a uniform speed, say 128 vibrations per second, by electro magnetism in the well-known way, in a room free from mechanical shocks or jolt, would any sound of the human voice uttered in that room vary the sound-waves emitted by that reed in a manner perceptible to the human ear?

A. I think the loudness might be decreased by a very loud sound made very near the reed.

411R.Q. As a matter of fact, did you ever know the sound of such a reed to be modified under the condition stated in your answer?

A. I never heard such a change.

421R.Q. Did you ever hear it stated by any expert in sound, or in any treatise on the subject, that the sound of such a transmitter could be so modified; if so, please give your authority?

A. No.

431R.Q. Suppose a reed vibrated in a manner and under the conditions stated in question 40, to be electrically connected with a receiver, such as A or A', situated at such a distance from the transmitter as to be free from danger of transmission of sounds through the air or mechanically, and vocal sounds such as articulate speech was to be spoken in proximity to the reed, would it be possible to distinguish the voice of the speaker?

A. I should not think it would.

Re-direct :

By L. W. SHERRELL, Esq. :

441R-D. Q. Suppose several reeds in an electric circuit passing through the helix of such an instrument as A or A', and the reeds exposed to the action of loud

sounds, such as a man shouting, do you think that there would be an appreciable difference in the sounds received upon the instrument A or A' from the sounds of the reels when *not* exposed to such external sounds?

A. Yes; I think there might be an appreciable difference.

Recross :

By W. D. BALDWIN, Esq. :

45 * Q. Did you ever see an apparatus such as that supposed in the preceding question tried, under the conditions named therein?

923 A. No.

46 ReQ. In what respect would the difference in the sounds received, as stated in your re-direct answer 44 be appreciable?

A. I think the sound would be partly interrupted and suffer changes of loudness.

47 ReQ. Would these changes of loudness be in the direction of increase or decrease?

A. Most likely both, but in all probability the decrease would be more marked than the increase.

ROBERT SPICE.

924 140 NASSAU STREET, NEW YORK, N. Y. |
Wednesday, Jan. 5, 1881. |

GEORGE B. SCOTT, being duly sworn, deposes and says in answer to interrogatories proposed by L. W. Serrell, Esq., counsel for Mr. Edison, as follows :

I Q. Please state your name, age, residence and occupation?

A. George B. Scott, 44 years old, No. 29 Patschen avenue, Brooklyn, Superintendent of the Gold and Stock Telegraph Co., of New York.

2 Q. Please state whether you are acquainted with Thomas A. Edison, and how long you have known him?

A. I have known him well since 1871?

3 Q. What was your business in 1871?

A. The same as at present.

4 Q. Please look at the two letters I now show you; state if you know who wrote them, where they have been and where they were obtained from?

A. They are in Edison's handwriting, undoubtedly. Secretary Brewer, of the Western Union gave them to me from the files in his office this morning, by the hand of my assistant, Mr. Pope, who delivered them to Mr. Serrell to-day.

Letters offered in evidence by counsel for Mr. Edison, to be marked "Edison to Orton, Aug. 31, 1877, and Oct. 15, 1877,"

5 Q. What knowledge have you of the early use of the Edison Carbon Telephone, by the Gold & Stock Co., or any instrument passing under your notice, personally?

A. Previous to May 31, 1878, Mr. Beatty, of Philadelphia, and the Western Union Tel. Co. had been experimenting with the Edison Carbon Telephone, and on or before that date I tried a pair between our office and New York and my house in Brooklyn. On that date I telegraphed T. A. Edison as follows :

"MAY 31, 1878.

"TO T. A. EDISON, Menlo Park :

"Your instruments are a success on the Brooklyn wire.
"Can you furnish me with two induction coils and two
"more transmitters alone to fit up a set for merchants'
"circuits?

GEORGE B. SCOTT.

"Want to show you new design for combination box
"I am making. Reply."

"GEORGE B. SCOTT."

"Superintendent."

On June 1, 1878, I received a letter from George M. Phelps, superintendent of the Western Union Telegraph Company's manufactory, which I here have present, and which reads as follows:

"The Western Union Telegraph Company's Manufactory
"62 to 68 New Church Street.

"G. M. Phelps, Sup't."

"New York, June 1, 1878.

"Geo. B. Scott, Sup't:

"Dear Sir—I sent over yesterday one of the Edison
"carbon transmitters for telephone, the mate of which we
"have in circuit here.

"Of course, it is not decided yet to mount them in the
"form presented. The local battery fits to be attached to
"the two binders at the bottom of the case.

"The automatic spring in the fork of the hand tele
"phone close the local circuit when the hand telephone is
"out.

"The ungueto call batteries in this pair are very power
"ful. I think they will "call" easily on a circuit to Phil
"adelphia.

"Of course, it may be desirable to mount the carbon
"transmitter with arrangement to call by the local battery.
"Very truly yours,

"G. M. PHELPS,

"Sup't."

GEORGE B. SCOTT.

"Q. Please state whether or not any instrument was
"received by you from Mr. Phelps, and if so, what was it
"and what was done with it?

A. The telephone referred to in this letter was re-
"ceived either by Vice-President Walker or myself and
"tested in various ways. My only way of knowing when
"is by the date of the letter. I remember seeing that par-
"ticular instrument. On June 10, 1878, I shipped to Su-
"perintendent Merrillue, Western Union Telegraph Com-
"pany, Philadelphia, an Edison carbon telephone, to be
"tried between that city and New York. I determine the
"date by several telegrams which passed between us on
"the next day, of which I have the originals here present,
"and which read as follows:

"New York, June 20, 1878.

"Telegram to JAMES MERRILLUE, Superintendent, Phil-
"adelphia:

"I shipped you by express last night a combination
"carbon telephone.

"We want to test the line as early as possible, as we
"must exhibit it to the Western Union Executive Com-
"mittee to-morrow at noon. Can you test to-night?
"Answer.

"GEO. B. SCOTT,

"Superintendent."

To which telegram I received the following answer: 933

"PHILADELPHIA, June 20

"Geo. B. Scott, Superintendent, New York:

"Not arrived yet, but I will connect you to Mr. Bent-
"ley now. He is waiting. Are you ready?

"J. MERRILLUE,

"Superintendent."

To which I answered as follows:

034 GEORGE B. SCOTT.

" New York, June 20, 1878.

" Telegram to James Merrihue, Philadelphia:

" We are ready.

" GEO. B. SCOTT,

" Superintendent."

I cannot now remember the issue of that experiment, we had so many.

Among other carbon telephones that were made for us, I remember particularly the following lot, described in the following letter:

035

" New York, June 24, 1878.

" To G. L. WILEY, Assistant Superintendent, New York :

" Dear Sir—I charge you with the following apparatus " received from Edison :

" Two induction coils, with switch and key, in box.

" Six induction coils, box alone.

" Eight carbon transmitters.

" Two twenty-ohm sonometers.

" Two receiving telephones.

" Yours respectfully,

" GEO. B. SCOTT,

" Supd."

036

Said Mr. Wiley was assistant superintendent in our company at that time. He had charge particularly of our private line department, in which department nearly all the telephones we used were located. This letter shows that I regularly notified him to charge his department with the instruments named therein, to be used on the regular lines of our customers; this being our mode of procedure of keeping accounts of instruments and material.

GEORGE B. SCOTT. 387.

In order to show that previous to June 20, 1878, we were prepared to furnish Edison telephones to the public, I give next a letter written by me in answer to an inquiry from Prof. Chandler:

" New York, June 20, 1878.

" PROF. CHANDLER,
" 31 East 54th st., City.

" Dear Sir:

" I have submitted your request to Vice President Walker, who instructs me to communicate to you the " following:

" He will sell the telephones you wish as the prices " named below, for the purpose of illustrating your lec- 038:
" tures.

" 2 Phelps' hand Telephones.....\$24 00

" 2 Gray's " " " " " 24 00

" 2 Edison's Carbon Transmitters, with induction

" coils in box, complete,.....34 00

" The Edison Transmitters are used with either

" Phelps' or Gray's telephones as receivers, as this gives

" the best results.

" Yours respectfully,

" Geo. B. Scott,
" Superintendent."

On or before June 25, 1878, I received from Mr. Edison two carbon Telephones which had been made by the Western Electric Manufacturing Co., which were sent to Mr. Edison that he might test them and see if they were satisfactory.

Vice President Walker instructed me to put those two telephones upon a wire we then had running from our office to the corner of 291 and Broadway, where we had and still have a branch office. I remember that they were placed on that line and worked for a short time.

039:

940 GEORGE B. SCOTT.

I determine the date by the following letter:

"MEXLO PARK, N. J., July 24, 1878.

"Geo. B. Scott, Supt.,
"New York.

"Dear Sir:

"We send you to-day two transmitters and two coils,
"shipped to us by Western Electric Manufacturing Co.,
"which we have tested and found good.

"Very truly,

"T. A. Edison.

"G."

941

Although this letter is dated July 24th, 1878, I received it on June 24th or 25th, 1878. This I know as follows:

At that time I kept a journal, in which my clerk entered in consecutive order every letter I received. Gave it a consecutive number in said journal, and marked the corresponding consecutive number on the letter, and a summary of the letter was also entered in said journal.

The letter above mentioned appears among the letters received on June 24, 1878—thirteen in number—and which lot of letters are thirteen leaves ahead of the entries under date July 24, 1878. I have said journal here present for the inspection of counsel. There is no entry of my letter from Mr. Edison under date of July 24 or 25, 1878. It is my practice to make a memorandum of instructions I may receive, on the face of letters—always adding the date to my initials. Such a memorandum appears on this letter in pencil, as follows:

"V. P. Walker says put on 23d St. line at once.

"G. S., June 25th."

This memorandum was written by me.

GEORGE B. SCOTT.

943

On June 25, 1878, I gave Assistant Supt. Wiley instructions to put a pair of Edison carbon telephones on the private wire of James A. Barker, in Irvington, New York. This was done because the magneto telephones on said wire were not giving good satisfaction. I determine this date from examination of the records of our private line department.

On July 23, 1878, we put Edison carbon telephones—I don't know how many; there were two or more—on the private line of Chas. L. Wright & Co., of New York. These were the first sets of Edison telephones we put out on regular working lines apart from the experimental trials that had been going on for some time. I fix the latter dates by records of private line department.

944

7 Q. Please explain what you mean by the expression "private line?"

A. I mean special wires erected and maintained by us for particular parties or firms between their places of business and their factories or warehouses, and which were used by those parties only. In such cases the wires, instruments, telephones, batteries and everything connected therewith remained the property of this company, and were leased to our customers at a regular monthly or annual rental, as the case might be. This class of business formed a separate department of our company, under the charge of Assistant Supt. Wiley, as before mentioned.

8 Q. State whether or not you know of the use of the Edison Carbon Telephone between the Western Union Office and Mr. Bentley's office in Philadelphia?

945

A. I have been present several times at such trials and have spoken to Mr. Bentley through the telephone, but I cannot remember the dates. I believe some of those trials were before June 20, 1878, and some afterward.

9 Q. Do you know where any of the original Edison Carbon Telephones are?

A. I believe them to be nearly all in possession of the American Bell Telephone Co., of Boston, because all

946 GEORGE B. SCOTT.

the original and experimental telephones in the possession of the Gold and Stock Co., have been turned over to said American Bell Telephone Co.

Cross-examination by Col. DYER:

108Q. What was the business of the Western Union Telegraph Company's Manufactory you have testified about?

A. Their business was to manufacture instruments for the Western Union Co.

118Q. For such manufacture, did they have special machinery and ingenious and skillful mechanics?

A. They did.

947 128Q. Capable of putting any rough contrivance of an inventor into the best mechanical and commercial form? A. They were capable of putting such ideas into good form and shape.

138Q. Was the business of the Western Electric Manufacturing Co. the same as that of the Western Union Manufactory?

A. It was not. They were a regular commercial firm and manufactured and sold telegraph instruments and supplies to the public, and in addition other commercial electrical apparatus.

148Q. This last named company have also suitable machinery and skillful and ingenious workmen, able to put crude inventions in the best mechanical and commercial form?

948 A. They had suitable men and machinery to put such ideas into good shape.

(Cross-examination waived by counsel for Bell and Blake.)

GEO. B. SCOTT.

Adjourned to Thursday, January 6, 1881, at 10 o'clock A. M.

G. T. P.,
Notary.

HENRY BENTLEY.

949

OFFICE OF L. W. SERRELL,
140 NASSAU ST., NEW YORK, N. Y.

THURSDAY, JAN. 6, 1881.

Met pursuant to adjournment.

Present—

L. W. SERRELL, Esq., on behalf of T. A. Edison.
J. J. SWEENEY, Esq., on behalf of Messrs. Bell and Blake.

Col. G. W. DYER, on behalf of Messrs. Irwin, Veehler, and Richmond; and
W. D. BALDWIN, Esq., on behalf of E. Gray.

950

HENRY BENTLEY, being duly affirmed, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Please state your name, age, residence, and occupation?

A. Henry Bentley; age 48 years; reside in Philadelphia; occupation, telegrapher, and am president of the Philadelphia Local Telegraph Co.

2 Q. Are you acquainted with Thomas A. Edison?

A. I am.

3 Q. Have you ever had anything to do with Mr. Edison's carbon telephone, and if so, please state the circumstances connected with your early information of the same?

951

A. I was invited by Mr. Orton to make some experiment, and also by Mr. Edison, at the same time. Mr. Edison sent me, at Mr. Orton's desire, one or two of his carbon transmitters. A Mr. Adams, who was in Mr. Edison's employ at that time, since dead, brought them to Philadelphia and spent a day or two with us to assist in some of our first efforts, after which he returned to Menlo Park, and we subsequently worked with them

ourselves—that is more particularly myself and S. M. Plush, Superintendent of our company. At our suggestion Mr. Edison made several changes in the form of the transmitter.

"Q. Please state the times when you first had to do with this, and how you determined the dates?

A. We worked the Edison carbon transmitter from one part to another of the building, at southeast corner Third and Chestnut street, and 107 South 51 street, an adjoining building, Philadelphia. This was prior to Feb. 4, 1878. Upon Feb. 4, 1878, we worked to Menlo Park on No. 7 wire of the Western Union. I determine this date by the daily log of our company, kept by the
603 Superintendent, which log I have here present, and in which is the following entry.

"Testing carbon transmitter with Edison, on 7, at Menlo Park."

The date of that entry is Feb. 4, 1878. This was precisely operative. The next entry on the log pertaining to the carbon transmitter is March 2, 1878, which is as follows:

"March 2, 1878.

"Mr. Adams here from Menlo Park with Edison's carbon telephones. Made test to Wilmington and
604 back."

We worked this instrument to Wilmington and back through a loop. The next entry appears March 20, 1878, as follows:

"Friday, March 8, 1878.

"Test with Edison's phonograph and carbon telephones to Baltimore via Pittsburgh, failure."

This word "failure" means that the Baltimore operator telegraphed that he failed to hear us. The next entry on the log is March 10, 1878, as follows:

"Making tests with Menlo Park via New York, 138 miles; also to Menlo Park direct; got talking distinctly, also singing; words in conversation sound muffled."

This is a correct entry of what was done at that time. Next entry is March 13, 1878, as follows:

"Making telephone test with Menlo Park, with new disk spring; test very satisfactory."

Mr. Edison wrote to me and stated that he had made a spring; he sent me a spring made of brass, and thought there was great advantage in it. After experimenting with it, however, we did not agree with him. The articulation, when conversation was carried on in a low voice, was very rough. The next entry March 15, 1878 is as follows:

"H. B. is New York.

"J. M. in Washington.

"Made telephone test 110 miles; got what was said distinctly."

H. B. is myself, and J. M. is James Merrihow, Superintendent of Western Union Telegraph Co., at Philadelphia; he was in Washington at this date. The next entry by Superintendent is March 20, 1878, as follows:
007

"Stringing a wire to Franklin Institute for telephonic exhibition to-night."

I remember this. I intended on this date to explain Edison's carbon transmitter; but not being able to get there, living out of town, I desired our Superintendent, Mr. S. M. Plush, to take charge of the same for me

908 HENRY BENTLEY

which he did; soon after this, I also gave an exhibition of the carbon transmitter at the Franklin Institute, with the most satisfactory results.

Answer objected to by counsel for Gray as incompetent and inadmissible. It appearing from the witnesses own statement that he is reading entries made by another person.

Counsel for Edison replies that the witness is entitled to examine any record to which he may have had access from time to time for refreshing his memory.

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5. Please state whether or not you have had access from time to time, and examined the entries in the book which you now hold in your hand, and so as to be familiar with the contents thereof?

A. This is a book that I have frequently examined. This log contains the various doings about our office from day to day throughout the year. Any experiments which we make, or the erection of telegraphs or telephones are entered in this book by the superintendent. My frequent reference to the same, and my knowledge of the various affairs going on at our place, that I am positive that the book is accurately kept, for I am personally cognizant of a great part of the matter or matters which he enters there.

910

6 Q. Please state what instruments you exhibited at the Franklin Institute, and where those instruments are?

A. The principle point in this exhibition was to show the great power of the carbon transmitter over the ordinary Magneto Telephone as a transmitter. The Edison carbon transmitter was used at Third and Chestnut streets. Singing, whistling and playing on the cornet was distinctly heard at that time.

HENRY BENTLEY.

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7 Q. Please state whether any Edison's carbon transmitters were used publicly at the Franklin Institute, and under what circumstances?

Adjourned for 30 minutes.

G. T. P.

Examination continued:

A. Subsequently to this exhibition at the Franklin Institute, a carbon transmitter was introduced in the Franklin Institute. I have not the date, but can send it to you. This instrument remained there for several months, and in fact until the Philadelphia Local Tel. Co. discontinued its telephone exchange, by transferring its interest to the Bell Tel. Co. of Phila. This Edison carbon telephone was connected with the Philadelphia Local Telegraph Co., and was used by gentlemen connected with the Franklin Institute, and various scientific gentlemen who went there to see it working, in communicating between the Franklin Institute and our office, also with other points through our office.

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8 Q. Did you make use of the Edison carbon transmitter at any other place about this time?

A. March 25th, 1878, I connected one of our telegraph offices at Broad and Chestnut streets, Philadelphia, with my private office, and used the said transmitter daily for several weeks. I have here present one of the instruments made use of by me.

903

(Instrument here present offered for the inspection of the respective counsel, and as Mr. Bentley does not wish to part with the instrument, notice is given that a drawing will be made of the same, to be marked "Bentley's Exhibit Edison's Carbon Telephone, March 25th, 1878. No. 2.")

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D Q. Did you, in the month of April, 1878, make use of any Edison carbon transmitters?

A. I did; April 20 and 3d, 1878, I worked Edison's carbon transmitter from Philadelphia to New York, conversing with several in the Western Union telegraph office there. Among others with whom I conversed was B. H. Rochester, the Treasurer of said Co.

[Q. I ask you whether Edison's carbon telephone was ever publicly exhibited in Philadelphia, Pa.?

A. It was in the Academy of Music, and an account of the same was published in the Philadelphia *Enquirer* Tuesday, April 16th, 1878, and in various Philadelphia papers of or about that date.

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(Counsel for Edison offers the account given in the Philadelphia *Enquirer* above referred to, of the entertainment given in the Academy of Music, to be marked "Edison's Exhibit L.")

11 Q. Did you have anything to do with the exhibition of the Edison carbon telephone at the Smithsonian Institute at Washington?

A. I did; I made arrangements for the exhibition of Edison's carbon telephone at the meeting of the National Academy of Science, at the Smithsonian Institute, at Washington, and had the same connected by a wire of the Western Union Telegraph Co. with the Western Union Telegraph office, at Tenth and Chestnut

500

streets.

12 Q. Is this the exhibition and use of the carbon telephones mentioned in the Washington *Post* of April 10, 1878, and also referred to in the *Speaking Telephone and Electric Light*, by Prescott, pages 575, 580 and 581?

A. That is it.

13 Q. Can you produce any other of the Edison Carbon Telephone's made up of by you, if so, please do so,

HENRY BENTLEY.

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and state the time, as near as you can, when they were made use of?

A. I am not able to produce any others than the four which I have here.

The instruments present, offered for inspection of the respective counsel, and as Mr. Bentley does not wish to part with the instruments, notice is given that a drawing will be made of the same, to be marked "Bentley's Exhibit Edison's Carbon Telephone, Nos. 1, 2, 3 and 4."

14 Q. Please state which of these instruments was furnished to you first?

008

A. Transmitter No. 1, 2 and 3 were in use at the same time. No. 4 was also tried at the same time, but not with satisfactory results. The circuit-breaking key upon Exhibit 3, I had put on myself. I suggested to Mr. Edison that a transmitter made to hold in the hand, like Nos. 1 and 2 were objectionable, because of their frequently getting out of adjustment, by the combined warmth of the hand in holding them, and the breath in talking into them, as well as by their being suddenly jarred by being taken up and laid down, or by any sudden concussion. I found that the hard rubber of which they were made expanded very greatly from the warmth of the hand, and contracted greatly after the warmth of the hand was removed from them, and they were laid down and not used for a short period, so that the rapid changes from heat and cold constantly interfered with the proper adjustment of the carbon button. He then made another form of transmitter, which he sent me, which is here marked No. 5. This worked more satisfactorily than either of the others.

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15 Q. Where and when were other Edison's Carbon transmitters publicly used, to your knowledge?

A. Sept. 14, 1878, on a line from my office, Third and Chestnut streets, Philadelphia, to Frankfort Arsenal,

970 HENRY BENTLEY.

Philadelphia. September 20, 1878, from my office to the permanent exhibition, West Philadelphia. Sept. 20, 1878, connecting my office with the Drug Exchange on the same date, connecting the Commercial Exchange with my office.

Sept. 24, 1878, it was placed on a line from my office to that of Jessen & Hanniffin in Philadelphia.

Sept. 25, 1878, it was placed on a line running from my office to that of Allison & Sons, West Philadelphia.

All the above Edison Carbon Telephones were confined in use until the Philadelphia Local Telegraph Company discontinued its Telephone Exchange. In addition a large number of others were placed on lines from that time onward until the Philadelphia Local Telegraph Company ceased to act in the business.

10 Q. Was there any reason as far as you know why the Edison Carbon Transmitters were not publicly used to a greater extent than what you have named before September, 1878?

A. The reason why we did not use them to a greater extent along prior to this was our inability to obtain them from the company manufacturing them.

17 Q. Do you know whether Mr. Orton wrote to you upon the subject of the Edison Carbon Telephone, and if so, about when and what was the result of such correspondence?

A. Mr. Orton wrote to me to the best of my belief, I think I have the letter at my office, to the best of belief in February, 1878, asking me to make some experiment with a view to the introduction of the Edison Carbon Telephone. I agreed to do so, and Mr. Edison sent me the telephones sometime afterwards as I have previously stated. I said to Mr. Orton after I had seen the Carbon Transmitter at the Western Union's Office that I believed it contained the germ which would revolutionize telephony, and I thought immediate attention should be given to its development. Mr. Orton thereupon asked Mr. Edison to send me the transmitter that I might make experiments with it.

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18 Q. State whether or not any of the Edison Carbon Transmitters had rubber between the diaphragm and the carbon and whether anything was substituted?

A. Yes; the first carbon transmitter I saw had rubber between the diaphragm and the button. I tried various articles, not with entire satisfaction; among other things, glass. Mr. Edison sent me a spiral brass spring, which he thought would improve it, which was placed between the diaphragm and the button. I was not satisfied with the results of this spring. The reason I was not satisfied with the rubber under the diaphragm was because of its frequent liability to expand and contract from sudden changes of temperature, so varying the pressure on the carbon button as to render it necessary for me to frequently alter its adjustment. I found the most satisfactory result to be obtained by placing a piece of wood between the diaphragm and the button. This gave us the most satisfactory attention we had yet obtained. Mr. Edison suggested that a piece of metal be placed between the diaphragm and the button, whereupon he sent me from Menlo Park two diaphragms, with a small piece of brass tubing soldered on the under part of the diaphragm, such as are now in Exhibits Nos. 1 and 2. When No. 1 was originally received it had not the metal underneath the diaphragm, as is now found in it.

19 Q. To what extent and by whom besides yourself was the Edison Carbon Transmitter publicly used on the occasions mentioned by you, on Feb. 4, March 24, 10th, 16th, and at the Franklin Institute, and March 25th, all in 1878?

A. Mr. S. M. Plush, Superintendent of the Philadelphia Local Telegraph Company, participated in these experiments with me on those dates. They were used by various other parties on those dates. I cannot mention any further than Mr. Batchelor, Mr. Ellison, Mr. Adams, Mr. Decker, Mr. Homan, Actuary of the Franklin Institute; also Mr. J. B. Knight, of the same institution; also Prof. Barker, of the University of Penn.

sylvania—we connected him often. We made experiments on many other days except those mentioned, of which we kept no accounts. We left a carbon transmitter at the Franklin Institute for the use of its officers and the many scientific gentlemen who called there. This was a public use, and we endeavored to have it as public as possible. We placed this instrument there, believing it to be the most conspicuous place in which we could place it, as we were not able, at this period, to supply instruments for the public to use.

Cross-examination, by William D. Baldwin, Esq., counsel for Mr. Gray:

977 10 xQ. I presume, Mr. Dentley, you have no pecuniary interest in any of Edison's inventions, or in the subject matter in controversy?

A. As president of the Philadelphia Local Telegraph Company, and as a stockholder in the same, I am interested in telephony generally. I am personally a friend of Mr. Edison, as well as several other inventors, but I know of no interest that I would have in telephony which would cause me to be influenced in making any statement which I have here made.

30 xQ. As I understood it, then, your position is that of a disinterested witness, who is a warm personal friend of Mr. Edison and an enthusiastic admirer of his genius and inventions?

A. I am an admirer and a warm, personal friend of Mr. Edison, Mr. Gray, Mr. Phelps, and several other gentlemen whose names are connected with telephones.

21 xQ. You are, I believe, a telegrapher of many years' standing, and of large and varied experience as such?

A. I have had considerable experience in telegraphy and in management of telegraphs.

22 xQ. As a telegrapher, did you take a great interest in experimenting and investigating the telephone, when it was called to your attention?

A. I did; to the best of my knowledge and belief, the first telephones placed before the public in Philadelphia were Professor Bell's magneto-telephones, sent to me by Mr. Hubbard from Boston. This was in the early spring of 1877. I placed one of these magneto-telephones in the Philadelphia Stock Exchange, to see if I could introduce it among the bankers and brokers. I found that it was not satisfactory, more particularly on account of the great amount of induction, consequent upon the immediate proximity of a large number of telegraph wires.

23 xQ. Examine the cut now shown you on page 36 of Prescott's speaking telephone, and state whether it is a correct representation of the first carbon transmitter sent you by Edison, as stated in your third answer?

A. That to the best of my knowledge is very similar to the first transmitter, or the one first sent me.

Copy of said cut is already in evidence in this case as Exhibit Journal of the Telegraph, April 16, 1878; fig. 2.

24 xQ. Please state what changes Mr. Edison made in the form of that transmitter at the suggestion of Mr. Plish and yourself, as stated in your third answer?

A. Mr. Edison placed a piece of metal underneath the diaphragm in order to improve its articulation. This piece of metal was not suggested by me, but I stated to him that he must have some substance there which would not expand and contract so much as the rubber tubing which he had placed there. I thought a piece of hard wood would be best, but it was difficult to hold the wood there in a proper position always, so he soldered a small piece of brass tubing underneath the diaphragm. This we continued to use. Mr. Edison also sent me a spiral brass spring to go underneath the diaphragm on the button, but we thought it caused too great vibrations.

35aQ. Exhibit Bentley's Exhibit Edison's Carbon Telephone No. 1 is the first transmitter sent you by Mr. Edison, is it not?

A. I am not sure whether this is the first instrument he sent to me. One or two instruments were sent back to him. To the best of my knowledge and belief the instruments marked No. 1 and No. 2 are the first instruments sent to me by Mr. Edison. One, No. 1, was sent back and cut open by Mr. Edison to show the inside, so that a drawing could be made of it. Which ever one of those is the first, had the rubber tubing in it. We placed a solid piece of soft rubber in it in place of the tubing. We put in paper, and leather and many substances.

288 26aQ. How long did you use the first transmitter sent you without alteration of any kind?

A. To the best of my recollection, we removed the rubber tubing which Mr. Edison had placed there, and tried in its place various other substances within a week or ten days after we received the first transmitter.

27aQ. Which of the substitutes you used for rubber tubes produced the best results?

A. A piece of hard wood produced, in our opinion, the clearest articulation.

38aQ. Who suggested and who applied a piece of wood?

A. I did. I think the first public exhibition of any carbon telephones by me, outside of our own building, was one at the Franklin Institute.

984 29aQ. Did the carbon transmitter exhibited at the Franklin Institute have the piece of hard wood in it or the soft rubber tube?

A. I do not remember.

30aQ. How was the carbon transmitter subsequently introduced in the Franklin Institute, stated in your seventh answer, constructed in this respect?

A. I think it had the metal tubing underneath the diaphragm.

31aQ. How was it as to the one exhibited at the Academy of Music, April 16, 1878, as stated in your tenth answer?

A. To the best of my belief Mr. Deteler, who came over to Philadelphia with Mr. Edison's phonograph, brought that transmitter with him, and I do not know how it was constructed.

32aQ. How was the telephone used at Washington at the Smithsonian Institute, as stated in your eleventh answer, constructed?

A. That carbon telephone, to the best of my belief, had a piece of metal tubing underneath the diaphragm, and was taken to Washington by Prof. G. F. Barker. I sent it with him to make the experiment with me.

33aQ. At what time did you receive Exhibit No. 3?

A. I received No. 3 written a few weeks—I cannot say the date—within a few weeks after No. 2. I don't remember whether the hard rubber contact piece between the carbon and the diaphragm was on it when it first came.

By Col. DYER:

34aQ. These instruments you have furnished as exhibits, do you know where they were manufactured, and by whom?

34aQ. They were all sent me from Mr. Edison's shop by Mr. Edison, and I have always understood from him that they were made by him. To the best of my understanding and belief they were so made.

35aQ. In regard to the removal of the rubber tubing and the substituting of something else in place of it would you have been willing to have attempted the general use of those instruments without the change in their construction you have testified about?

A. No, I would not have been satisfied to use it in that form with the rubber tubing, although it would not

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have appeared so satisfactory to the public as with the metal.

HENRY BENTLEY.

Adjourned to Friday, January 7, 1881, at 10 o'clock A. M.

G. T. P.

140 NASSAU STREET, NEW YORK, N. Y.
Friday, January 7, 1881,

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Met pursuant to adjournment.
Counsel present as before.

GEORGE M. PHELPS, JR., being duly sworn, deposes and says, in answers to interrogatories propounded by L. W. Scroll, Esq., as follows:

1 Q. Please state your name, age, residence and occupation?

A. George M. Phelps, Jr., 37 years of age, residence, Brooklyn, N. Y., occupation, Supt. of the Western Electric Mfg. Co., New York.

2 Q. Please state whether you are acquainted with

800 THOMAS A. EDISON, and if so, how long you have known him?

A. I am, and have known him about seven years.

3 Q. Do you know anything in relation to the early use of the Edison Carbon Telephone, and if you can give any dates upon the subject, please do so?

A. The earliest date of its use, outside of experimenting in the workshop, of which I have personal knowledge, is May 23d, 1878. On that date I used one or two carbon transmitters in the lecture room of Dr. Wells'

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Church in Brooklyn, for the purpose of exhibition to some friends and acquaintances. There were also present enough other persons to make an audience of about 300. I used on this occasion a carbon transmitter, which I understood to have been made by Mr. Edison, and also a carbon transmitter, made at the factory of the Western Union Telegraph Co., New York. On that occasion I gave a lecture, of which I have notes here present. This lecture was intended to be a brief exposition of the history of the telegraph and also to give some account of the principles of the telephone. I gave a pretty minute description illustrated by a magneto-telephone, taken to pieces before the audience; but gave no detailed description of the carbon transmitter. The carbon transmitter was used only at the distant end of the line, from which communications were sent to the lecture room. The sending instruments were in the pastor's residence, not far from the church building. During the exhibition, Dr. Wells, the pastor of the church, and several other persons were in the room from which the transmissions were made. The speaking and singing at the transmitting end was done by several persons. The exhibitions of the telephone were very successful. A quartet of individuals singing together into the instrument were heard distinctly by all the audience, and Dr. Wells' voice was recognized by the audience when he addressed them through the telephone. The carbon transmitter was used in nearly all the experiments made during the evening. The instrument used as a receiving telephone was a magneto-telephone, of the variety known as "Crown."

4 Q. Had you before this lecture been familiar with the use of the magneto-transmitter; and if so, how did the carbon transmitter on this occasion compare in effectiveness with the magneto-transmitter which you had before used?

A. I had been familiar with the use of the magneto-telephones, and found the carbon telephone to be much

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more efficient, especially in the matter of power. I used the carbon telephone for this exhibition, because I could obtain some striking results in enabling a large audience to hear what was said over the wire than I could do with any magneto-telephone that I was familiar with.

5 Q. What is the next one of the Edison carbon telephone with which you are personally acquainted?

A. I have no specific dates as to particular uses after the exhibition mentioned. On May 31, 1878, there was delivered from the Western Union Telegraph Company's factory to the Gold and Stock Telegraph Company of New York, a sample Edison carbon transmitter. I find this entry in my note book, under date of May 31, 1878:

"1 D. S. cottage cell box, No. 037, with Edison carbon transmitter (allow pattern), and one hand telephone, No. 3215, sent to G. and S. Co. for trial." This entry is in my own handwriting, and was made on or about the date given. The note book containing this entry is one that I used for noting various transactions relating to the business of the Western Union Manufacturing in the summer of a diary.

The witness has the book here present, and it is tendered to the respective counsel for examination.

8 Q. Please state whether or not any carbon telephone were made at the Western Union Manufacturing in 1878, and if so, under what instructions, how many, and when?

A. A very considerable number of carbon telephones were made during 1878 at the Western Union Tel. Co.'s factory upon orders given by the Gold and Stock Tel. Co. The first order given was under date of May 31st, received at the Western Union factory June 1st, and was for 500 Edison carbon transmitting telephones. The first delivery subsequent to the sample delivered May 31, above referred to, was made on June 13th, when another delivery of one was made. Another delivery of

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two was made June 21st; another July 17th; another delivery of ten July 24th; another delivery of fifty July 24th, and the whole delivery of 500 was completed at different dates by Dec. 10, 1878.

7 Q. What was the character of the instruments comprising this order?

A. They were of the same character as the instruments which I have before me been produced, marked "Exhibit Edison Carbon Telephone, S. L. G." I think this instrument is one of the make of the Western Union Co. because it embraces points in its construction which originated at the Western Union factory, and which characterize nearly, if not quite all, the Edison Carbon Telephones made in that factory. These points are the hemispherical knob upon which the diaphragm rests made of thin sheet brass and gunned to the glass disc; the ear provided for attaching the transmitter to a jointed arm, and the shape of the iron case. Soon after we began making these, others were begun by the Western Electric Manufacturing Co., of Chicago, and some of those made by them may have resembled this one in the details I have mentioned. In most of those made at Chicago the back of the case was more bulging, instead of conical, and the whole case was heavier, and the ear for attaching the transmitter to the jointed arm did not form a part of the transmitter case, but was made as a separate piece attached to it, and the adjusting screw had a slotted instead of a cup-like head. And instead of the hemispherical knob attached to the glass disc in this exhibit, the later Chicago transmitter had a piece of brass tube cemented to the diaphragm, and having three feet at the end nearest the carbon.

8 Q. State whether or not the Edison carbon telephone as used since 1878 corresponds generally with the instrument here present marked "Exhibit Edison Carbon Telephone?"

A. Yes; I consider they do.

9 Q. What differences, if any, can you point out?

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A. The use of a hard carbon disc in place of the glass disc in the exhibit. It had a metallic facing just as the glass disc has, but upon the opposite side serving for the attachment of contact strip. The soft carbon button was retained, as before; also, the electrical connections. I would like to look at some memoranda before answering this further. [After the return of this witness he says:] I know of no further alterations, and have consulted my memoranda for that purpose.

10 Q. Do you know anything in relation to telephone instruments furnished for use at Mr. Orton's house?

1001 A. I have in my note book, the same book referred to before, under date January 16, 1878, this entry:

"Telephone No. 48 sent to Mr. Prescott to be used for test at Mr. Orton's house."

I have no personal knowledge beyond this—the fact that the instrument referred to in this entry was sent at the date specified.

Cross-examination by J. J. Stronow, Esq.:

11 xQ. Was the lecture which you delivered at Dr. Wolf's Church substantially the same as the notes which you have produced and shown us?

1002 A. It was exactly the same so far as the MSS. is written out in full, and beyond that point substantially as indicated in the notes.

12 xQ. Please read in the Compendium, to be taken down as part of your evidence, the portion which I point out to you on pages 38 and 39 from the part written out in full?

A. I do so:

"When, about four years ago, Mr. Elisha Gray, of Chicago, exhibited his system of transmitting music over a telegraph wire in New York, a telegraph official present ventured to predict that people would before long be talking over the wires."

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"A reporter of the press was present—also! where are they met!—and the enthusiastic remark of the gentleman appeared in the newspapers. It caused quite a storm of ridicule; and, in derision, a story was told among telegraphers of an attempt that had once been made to talk over the wires, but resulted in failure, the New York operator not being able to endure the strong color of whiskey in the breath of the man talking in Philadelphia."

"The forecast that had seemed so wildly improbable became an accomplished fact in two years, the speaking telephone being exhibited at the Centennial Exhibition at Philadelphia."

1003 "And now, who has not heard or at least seen a telephone?"

13 xQ. Please read what is written on the last page of that note book, and state when you made the memorandum there written, and whether or not it is true?

A. I made those memorandums within a few days of the date stated, and it is true the memorandum is as follows. "Read May 23, 1878, at Dr. Wolf's church. Experiments with telephones very successful; audience of nearly 300; all knew distinctly both speech and music."

14 xQ. When did you first enter the employ of the Western Union Tel. Co., and in what capacity; how long did you stay with them, and in what capacities?

1004 A. I entered their service February 1, 1871, as a general assistant to my father, G. M. Phelps, and remained in their service in the same capacity till the discontinuance of their factory and its sale to the Western Electric Manufacturing Co., April 1, 1879.

15 xQ. What has been your occupation since then?

A. Since then I have been superintendent for the Western Electric Manufacturing Co., at the same shop.

16 xQ. Did your father pass from the service of the Western Union to that of the Western Electric?

A. He did not.

16xQ. In whose service is he now?

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A. In that of the Western Union Tel. Co. 188Q. In what capacity?

A. As an inventor and expert, in electrical instruments.

19 xQ. Is it your father, whose name is referred to as the inventor of those forms of telephone, commonly known as the Phelps Telephone, Point Crown Telephone and Double Crown?

A. He is.

By W. D. BALDWIN, Esq.:

20 xQ. The receiving magneto telephone, known as the Crown used by you in the lecture you have mentioned, was the invention of your father, was it not?

A. It was.

21 xQ. Do you know when instruments of that form were first made or used?

A. They were first made some short time previous to May 23, 1878, and came into use some time after that date, as I recollect.

22 xQ. How many of them were in use when you first received the carbon transmitter you have spoken about?

A. Probably none.

23 xQ. Please identify the carbon transmitter you understood to have been made by Mr. Edison, by some exhibit or by some brief description?

1008 A. I see none here that resembles it very closely, as I recollect it, in outside appearance. In general feature it was the same as the one made at the Western Union factory, used at the same time. The precise difference in details I cannot at the present time recall. It did not have the ear and pin on it for attachment to a jointed arm.

24 xQ. By whom were the changes made in the carbon transmitter, made at the Western Union factory, devised?

A. By my father, Mr. G. M. Phelps.

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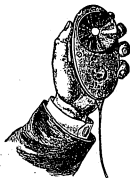
25 xQ. Was the carbon transmitter made at the Western Union factory and used by you at Dr. Wells' church substantially like the one shown in Patent 214,840 granted to Geo. M. Phelps, April 29, 1879?

A. I think it did not have the ear for attachment to a jointed arm, as shown in this patent, and I am not entirely sure that it had the hemispherical knob attached to the glass disc, but it was otherwise substantially the same as shown in this patent.

26 xQ. How long prior to May 23, 1878, had telephones been practically used on telephone exchange in New York City, to your knowledge?

A. Telephones were furnished to the Gold and Stock Telegraph Co. from the Western Union Telegraph Company's shop early in January, 1878. These were magneto-telephones. I do not know that they were used on telephone exchange. These were of the pattern called

"Phelps Duplex," similar as shown in Patent 200,280. This is the earliest delivery found in my note book. If I find an earlier one I will note it. The exact form of the instruments delivered at that time is shown in the cut on page 23 of Prescott's Telephone. Said cut is as follows:—



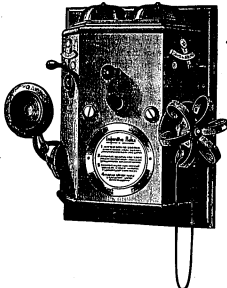
1011

(1012 GEORGE M. FIELDS, JR.

97 x Q. Please point out in Prescott's work the octagon call box instrument spoken of in your fifth answer?

A. It is fig. 310, on page 575 of the second addition. There is a difference between the cut and the instrument actually delivered, which is this: The cut shows a crown receiver attached, whereas the instrument delivered May 31 had a duplex receiver such as shown in the cut produced in my last answer. Cut as follows:

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28 x Q. What form of Edison carbon transmitter was that made under the order of May 31, 1878, for 500, referred to in your 6th answer?

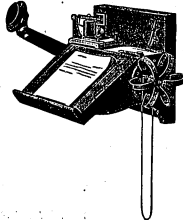
GEORGE M. FIELDS, JR. 1015

A. They were substantially like fig. 303, page 567 of Prescott's book, which cut is as follows:



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and were mounted on jointed arms attached to a small disc, substantially like fig. 305 on page 569 of said book, which cut is as follows:



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It is possible that some of this lot were made with the adjusting screw as shown in fig. 303. instead of the capstan head screw in Exhibit Edison Carbon Telephone.

Adjourned for one hour.

G. T. P.

By Col. DYER.

29 xQ. If the order of the Gold and Stock Telegraph Company, of May 31, 1878, was in writing, please furnish a copy of the same?

A. It was in writing, and I here furnish the following copy of the same:

1019

"Gold and Stock Telegraph Company,

"Western Union Building,

"New York, May 31, 1878.

"P. O. Box 5645.

"GEORGE WALKER,
"Vice-President.

"Geo. M. PHELPS, Esq.,
"Supt.:

"Dear Sir—I am instructed by our Executive Committee to give you an order for five hundred Edison carbon transmitting telephones, with Morse key and register induction coil. We do not wish to order any Edison receiving insts. at present, intending to use yours and Gray's hand insts. as receivers.

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"We wish this order pressed as rapidly as possible.
"When you have determined on the form and made an estimate of the price, I w'd like to hear from you.

"Yours very truly,

"GEORGE WALKER."

Endorsement on same.

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"Geo. WALKER, V.-Pres't G. & S. Co.

"June 1, 1878.

"Ordering 500 Edison Carbon Transmitting Telephones.

"phones.

"400 delivered up to Nov. 21.

"3 " Dec. 5.

"1 " " 10.

"500 completing order."

30 xQ. At this time was your company manufacturing any receiving instruments; and if so, which?

A. Yes, we were manufacturing the receiving telephones known as the Phelps Duplex, and had begun to make some receivers of the variety called "crown."

31 xQ. Was your company in a position to manufacture any telephone instruments at that time, or was it confined to those for the Western Union Telegraph Company?

A. We had the tools and were to manufacture whatever was ordered by the Western Union Telegraph Co.

Re-directed by L. W. SUMMERS, Esq.

32 xQ. Did the Western Union Manufacturing Company manufacture instruments for other parties than for the Western Union Telegraph Co., or pursuant to the order of the Co. in 1877 and 1878?

1022

A. The only manufacturing done was for the Western Union Telegraph Co., or upon their authorization, if for any other parties.

33 E-D Q. Do you know whether Mr. Edison had endeavored to get any telephones made at your factory earlier than the ones of which you speak?

A. I do not.

GEORGE M. PHELPS, JR.

140 NASSAU ST.,
NEW YORK, JAN. 7, 1881.

SAMUEL M. PLESH, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Please state your name, age, residence and occupation?

A. Samuel M. Plesh; I am 40 years of age; reside in Philadelphia, and am Superintendent of the Philadelphia Local Telegraph Co., and have been in that position about ten years.

2 Q. State generally what duties you have performed in that position?

A. I have had charge of the entire business; among other things I have kept what I call a "log." It is a daily memorandum book, and I have the same here present.

3 Q. Do you know anything in relation to the early use of the Edison carbon telephone, and have you any means of fixing dates?

A. Yes, I know of several public uses to which it was put in its earlier days, among the more important of which was on March 20th, 1878, when it was placed in the Franklin Institute for exhibition, at a public lecture that night, and allowed to remain for several days for the use of various business men and others who frequented that institution; a special wire was run for this purpose from the telegraph office, at 31 and Chestnut from this office. I place this date accurately by my memorandum book or log, here present, in which I made an entry at the time, which reads as follows, under date of March 20, 1878: "Stringing wire to Franklin Institute for telephone exhibition tonight."

4 Q. What kind of carbon telephone was this one?

A. I produce here a copy of the Journal of the Franklin Institute, dated April 1, 1878, in which is described

the carbon transmitter of Edison exactly as it was at the time of this exhibition and use at the Franklin Institute. This article was written by myself during the month of March preceding.

Counsel for Edison offers in evidence the copy of the Journal of the Franklin Institute before referred to, and makes pages 295 to 299, inclusive, an exhibit in this case.

5 Q. What object was there in leaving this Edison Carbon Telephone at the Franklin Institute for public use from March 20, 1878, onward to the time you have 1028 named?

A. It was left there at the request of the Secretary of the Institute, for the use of the business men and others calling to communicate with our office at Third street, and also for the purpose of introducing it generally when they could be obtained.

6 Q. Before this time, had you had anything to do with the Edison Carbon Telephones; if so, state what and when?

A. Yes, almost constantly from Feb. 4 until that time. This Edison Carbon Telephone was shown from time to time to numerous persons calling at the office of the Philadelphia Local Telegraph Co. It attracted a great deal of attention, and parties were very anxious to get them prior to the exhibition at the Franklin Institute. Parties came there to compare them with the magneto telephones that were in use before that time, and they compared very favorably with those magneto telephones. I only kept memoranda in this log book of those exhibitions which we considered wonderful. Among those memoranda I find an entry, under date of Feb. 4, 1878, as follows:

"Testing Carbon Transmitter with Edison, on 7, at 10 Park."

1030 SAMUEL M. PLESH.

On March 24, 1878, is the following entry:

"Mr. Adams here from Menlo Park, with Edison's Carbon Telephone. Made test to Wilmington and back."

On March 10th, 1878, is the following entry:

"Making test with Menlo Park via New York, 128 miles, also to Menlo Park direct: got talking distinctly, 'also singing, words in conversation sound muffled.' I remember the facts and the book confirms me as to dates. I had not known where telephonic communication had been made such a distance and would not have believed it possible. I have the following entry on March 15,

1031 1878.

"J. M. in Washington, made telephone tests 140 miles, got what was said distinctly."

J. M. are the initials of James Merrihew, Superintendent of the Western Union Tel. Co., who was in Washington that date, and carried with him that transmitter for the purpose of making this test with me, and the test was made at that time according to my record, and it was satisfactory to the parties making it. Also March 12, 1878, I made the following record:

"Making telephone tests with Menlo Park, with new 'disc' spring" test very satisfactory."

1032 Also March 25, 1878, is the following record:

"Put up at Broad and Chestnut streets, Edison set of telephone for test with this office." These were put there for general public information that they might call and test the instruments themselves with the office at Third and Chestnut streets. This place at Broad and Chestnut streets, was a public reception room of the Philadelphia Local Tel. Co. We kept a young man at the public reception room and parties going in there desirous of communicating with our executive offices, could use the telephone, and did use it. This Edison

SAMUEL M. PLESH. 1033

Carbon Telephone was there for a considerable time, but I don't remember how long. On April 2nd and 3d, 1878, they were making a comparison between Edison's Carbon Transmitter and Phelps Magento Transmitter in New York. I find this fact by reference to my log offered. There is nothing stated as to the results, but my recollection is that those in New York got nothing from the magento transmitter. By the carbon transmitter they got talking. I helped to place the carbon telephone instruments in circuit that were used in the test between Philadelphia and the Smithsonian Institute at Washington, where the Academy of Sciences was in session. This was done, April 18, 1878. I talked with Prof. Barker at Washington, and also heard Prof. Henry speak. My recollection of the date is further confirmed by the article in the "Washington Post" of April 19, 1878.

7 Q. Were you present at the examination yesterday of Mr. Henry Bentley, and did you or not refer to the entries made in your handwriting in your log book, by which to determine the dates in 1878, when the Edison carbon telephone was introduced at the various places mentioned?

A. I was present, and did refer to the entries in my log or memorandum book, by which to aid in determining the various dates in 1878 when the Edison carbon telephone was put into different places for further use.

8 Q. Please examine the instruments here present, marked Bentley's Exhibit Edison's Carbon Telephones, Nos. 1, 2, 3, 4, and state whether or not you have seen the same before, and where the instruments have been, as far as you know?

A. Yes; I have seen them, and recognize them as among the first. I believe they have never been out of the possession of Mr. Henry Bentley. They were furnished by Thomas A. Edison of Menlo Park, and I believe they were made in Mr. Edison's shop, as Mr. Adams so stated to me. I know that the instrument No. 1 was not open, so that the internal arrangement

1086 GEORGE L. WILEY.

could be seen. This was done some while after the instruments had been used by Mr. Bentley and myself. Parties wanted to know how they were made inable, and we took this means of showing them.

Cross-examination by W. D. Baldwin, Esq.:

9 xQ. By whom was the hemispherical projection on a piece of lined rubber, between the diaphragm and soft carbon button, shown in Bentley's Exhibit No. 3, devised and applied?

A. It was placed there by one of the mechanics in our shop, but I don't know who devised it.

1087 By Col. Dyren:

10 xQ. Did you hear the testimony of Mr. Bentley yesterday; do you agree with him in the various statements made by him?

A. Yes; I agree to all the statements made by him, which have any corroboration to the records of my memorandum book.

SAM'L M. PLUSII.

Adjourned to Saturday, Jan. 8, 1881, at 11 o'clock A. M.

GEO. T. PINCKNEY,

Notary.

1088

140 NASSAU STREET, NEW YORK, N. Y. }
Saturday, Jan. 8, 1881. }

Met pursuant to adjournment.

GEORGE L. WILEY, being duly sworn, deposes and says in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

GEORGE L. WILEY. 1089

1Q. Please state name, age, residence and occupation?

A. My name is George L. Wiley. I reside in Elizabeth, N. J., and am 31 years of age, and am now Assistant General Superintendent of the Metropolitan Telephone and Telegraph Co.

2Q. In what were you engaged in 1877 and 1878?

A. I was Assistant Superintendent of the Gold and Stock Telegraph Co., and Superintendent of the New York Private Line and Telephone Department of the Gold and Stock Telegraph Co.

3Q. Are you acquainted with Thomas A. Edison?

A. I am, and have known him since about 1871.

4Q. What early knowledge, if any, did you have of Mr. Edison's inventions of telephones?

A. So far as I can recollect, these instruments which I here produce are the first I ever saw. It is possible I saw others earlier, but do not recollect them.

1090

Instruments here offered in evidence by counsel for Edison to be marked—

"Wiley's Exhibit, Edison Carbon Telephone, No. 16," and

"Wiley's Exhibit, Edison Receiver, No. 33."

5Q. About what time did these instruments come into your possession?

A. I received the receiver October 10, 1877, and the transmitter October 17, 1877, which fact I am able to establish by entries in books which I have here present.

One of the books which I now produce for examination of counsel was started for the purpose of keeping a record of this particular class of instruments, and by the entries therein I determine the aforesaid dates. On October 15, 1877, I received transmitters identically the same as this transmitter No. 16, and they were numbered 23, 24, 25, 26,

1041

27 and 28, which fact I also determine by the said book, but I cannot tell now where they are. I had received from Mr. Edison, before the date of October 15, 1877, another carbon transmitter, but it did not work entirely satisfactory, and I cannot now tell exactly what it was.

92. Can you tell generally what was done with these carbon transmitters?

A. I worked these instruments, or others of the same lot—that is to say, I sent transmitter No. 25 and receiver No. 25, October 15, 1877, to 180 South street, New York, one of our branch offices that was connected with the main office 107 Broadway. I believe I worked those the same day. These instruments worked well while in adjustment; they had to be adjusted frequently.

104; These instruments were kept at the places named and used for some time. I am unable to state how long; it may have been a month. Many of our men tried and used these instruments. In comparison with the magneto telephones that had before been made use of, these carbon telephones were louder, but not as clear.

93. In whose possession have these instruments you have produce been?

A. They have been either in my possession or at the place, No. 108 Broadway, where our company had a store room, or in the possession of the party having charge of the office and store room aforesaid.

8 Q. Did Mr. Johnson have any such telephones as you here produce, from you?

104; A. He did; he had receiver 24 and receiver 27, and transmitter 24 and transmitter 27. He borrowed them with the understanding that they were to be used in public exhibitions about to be given by him. He said he was traveling and going to give such exhibitions.

9 Q. Did Mr. Edison, at any time, make for you or give to you any sketches or drawings of his carbon telephones?

A. He did, more than once, and I produce one set here; he made this one for me in my presence, on October 24, 1877.

10 Q. Did he or not, accompany the said sketch which you here produce, with any explanation?

A. He did, with considerable verbal explanation; he gave it as a description of the transmitters received on October 15 and 17, 1877. He made the sketch that is marked "Edison's Pressure Relay," and described how by a variation of pressure at the points of contact, with the carbon, the resistance of the circuit was increased and decreased, and stated that the carbon telephone was to some extent an elaboration of that plan. This is the substance of his statement. The lowest figure under the part marked "Pressure Relay," showed the carbon transmitter corresponding with the instruments that I had before received.

Sketch referred to is here offered in evidence by counsel for Edison, marked "Edison's Sketches for Mr. Wiley, Oct. 24, 1877."

11 Q. State who made the diagrams or sketch, and who wrote the dates?

A. Mr. Edison made the diagrams in my presence, and I then drew it in two places, and this paper has been in my possession ever since until it was produced here to day, and has remained unaltered in every respect.

12 Q. Have you any knowledge of the use of the Edison Carbon Transmitter after the date that you mention?

A. There were instruments received from time to time from Mr. Edison and from the Western Electric Co., and tested and used, and I find from entries that on June 29th, 1878, two Edison Carbon Transmitters, with induction coils, were placed on the line of James H. Barker; this was in the department of the Gold and Stock Co., known as the private line. On or about July 23, this same kind of Edison Carbon Transmitter was sent to Charles L. Wright & Co., for their private line, and our records prove that shortly after this time the

[018] GEORGE B. PRESCOTT, JR.

Edison Carbon Transmitter was extensively used. Up to the end of October, 1878, probably 150 Edison Transmitters had been received, and probably 60 or 70 had been put in use by the Co. on lines leased by them to various firms and individuals.

13 Q. Please state what prominent feature existed in the carbon telephones received by you from Mr. Edison, in October, 1877, and whether or not those same features are the prominent features in the carbon telephone transmitters in public use, as far as you know?

A. Variation of tension, in a closed circuit, by variation of resistance caused by varying the pressure on a carbon button. It does continue to be a prominent feature in the carbon telephones in public use.

GEO. L. WILEY.

140 NASSAU STREET, NEW YORK, N. Y.,
Saturday, January 8, 1881.

GEORGE B. PRESCOTT, JR., being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Please state your name, age, residence and occupation?

A. My name is George B. Prescott, Jr., 23 years of age, residence New York City, occupation Assistant Electrician Western Union Telegraph Co.

2 Q. Are you able to produce any instruments made by or for Mr. Edison, connected with his improvements in telephones? If so, please do so, and name them?

A. Yes; two carbon transmitters, with the receivers, designed to be used in connection with them, and a break contact transmitter which was used in my office during the latter part of the year 1877—that is to say, two carbon transmitters, in wooden cases, Nos. 9 and 10, and two magnetic receivers, No. 7 and 8. The fifth in-

GEORGE B. PRESCOTT, JR. [051]

transmit is the device which I call the break contact transmitter, being a brass tube, with mouth piece, on an iron base; and the sixth instrument is a large iron diaphragm receiver, with iron base and electro-magnet.

3 Q. About when did the two carbon transmitters come into your possession?

A. I recollect very distinctly that during the time these experiments were made that Mr. Howard R. Butler was engaged in the same department with me. He was there some time in 1877. I presume, about the middle of 1877 to the early part of 1878. During my Christmas vacation in 1877 I went to St. Louis and returned in 1878, and Mr. Butler was in the same office during my vacation. My impression is that the experiments with these instruments were made before I went to St. Louis. They were made during the time Mr. Butler was at our office.

4 Q. Please refer to the letter of Mr. Edison to Mr. Orton, dated August 31, 1877, which has already been made an exhibit in this case, and state whether you know anything about the embosser mentioned therein?

A. I know that about the time these carbon telephone experiments were being made, that I had in my apparatus case a pair of instruments known as embosser, or as the embossing telegraph which had been made by Mr. Edison. This letter to Mr. Orton serves to associate the embosser in my mind with the experiments with the carbon telephone and the time when these took place.

(The instruments herein referred to are offered in evidence in this case, to be marked as follows:—

"Prescott's Exhibit Edison's Carbon Transmitter, No. 3."

"Prescott's Exhibit Edison's Carbon Transmitter, No. 10."

1054 GEORGE H. PRESCOTT, JR.

" Prescott's Exhibit Edison's Magnetic Receiver, No. 7."

" Prescott's Exhibit Edison's Magnetic Receiver, No. 8."

" Prescott's Exhibit Edison Transmitter, brass tube with mouth-piece and iron base."

" Prescott's Exhibit Edison Iron Diaphragm Receiver, with iron base and electro-magnet."

1055 5 Q. State whether or not the exhibits here produced by you have been in your possession or generally under your oversight ever since they were furnished you by Mr. Edison?

A. Yes, they have been, and no alteration has been made on either of them that I am aware of.

Q. So far as the instruments Edison's Carbon Transmitters No. 8 and 10 are concerned, state whether or not they were practically operative instruments, or whether or not they are now in a condition for use after adjustment?

A. I believe that they were operative instruments, and that they can be made so now without any material change; that is to say, they may need cleaning and adjustment to restore them to their original condition, so that they can be practically used.

1056 Cross-examination waived by counsel for Bell and Blake.

GEO. B. PRESCOTT, JR.

Adjourned to Monday, Jan. 10, 1881, at eleven o'clock A. M.

GEO. T. PINCKNEY,
Notary.

MONDAY, JAN. 10, 1881. 1057

Met pursuant to adjournment.

Counsel for Edison offers in evidence copies of the following patents, most of which have already been offered in evidence, but which are included in this list for convenience:—

Case No.	Filed.	Patented.	No. of Claims.
73	Mch. 13, 1873	Aug. 12, 1873	141,777
101	Aug. 13, 1875	Jan. 19, 1875	158,787
115	Apr. 6, 1876	Dec. 11, 1877	198,088
116	Apr. 6, 1876	Dec. 11, 1877	198,089
117	May 16, 1876	Jan. 16, 1877	186,330
118	May 16, 1876	Dec. 11, 1877	198,087
119	May 16, 1876	Oct. 10, 1876	182,596 1088
122		Dec. 19, 1876	185,507
133	July 20, 1877	Sept. 24, 1878	208,599
136	July 20, 1877	Apr. 30, 1878	203,014
143	Aug. 28, 1877	Apr. 30, 1878	203,015
146	Dec. 13, 1877	Apr. 30, 1878	203,013
147	Dec. 13, 1877	Apr. 30, 1878	203,018
151	Mar. 7, 1878	Apr. 30, 1878	203,016
175	Mar. 31, 1879	Nov. 25, 1879	221,957
		English Patent, No. 2,509, July 30, 1877.	
		English Patent, No. 2,596, June 15, 1878.	

Also a certified copy of Edison's caveat, No. 73.

Adjourned to Tuesday, Jan. 11, 1881, at eleven o'clock A. M. 1059

G. T. P.

140 NASSAU ST., NEW YORK, N. Y.,
WEDNESDAY, JAN. 12, 1881.

CHARLES HATCHERLOR, being recalled, in answer to interrogatories proposed by L. W. Serrell, Esq., deposes as follows:

I Q. Please look at the two letters from Mr. Edison to Mr. Orton, heretofore offered in evidence, dated Aug. 31, 1877, and Oct. 15, 1877, and state what instruments are referred to in them?

A. I believe the pair of telephones referred to in letter dated Aug. 31, 1877, are not here produced, but were identically the same as the drawings, figs. 1 and 2, in Edison's English patent 2,609, dated July 30, 1877. The two which he refers to as the "new pair" were a slightly different design in the outside case, but similar in the inside, and they were delivered as stated. The instruments referred to in letter dated Oct. 15, 1877, were similar to transmitter and receiver here present, and marked Prescott's Exhibit Edison's Carbon Transmitter No. 8; and Prescott's Exhibit, Edison's Magnetic Receiver No. 7; the call bells referred to were similar in design to the drawing shown on exhibit sketch, 142-12. I believe these instruments named in the letter were all delivered, and were practically operative instruments. They had been operated in the factory before they had been sent to New York.

I recognize "Bentley's Exhibit No. 4," as one of the instruments, made in Mr. Edison's shop, and sent to Mr. Bentley, after the Carbon Transmitters, with hard rubber cases, had been made. This iron case instrument was made about Jan. 1878, and Mr. Adams took several of them to Europe with him, in March, 1878. I recognize the four carbon transmitters produced here by Mr. Bentley, as instruments made in Mr. Edison's shop, and sent to Mr. Bentley. The hard rubber transmitters were made during November, 1877. I determine that data by Edison's Exhibit, sketch 140-13, as said drawing represents accurately the exhibits pro-

duced by Mr. Bentley with hard rubber cases, and marked Bentley's Exhibits Edison's Carbon Telephone Nos. 1 and 2. The instruments produced here by Mr. Wiley, and marked Wiley's exhibit, Edison's Carbon Telephone, No. 16., is an instrument that was made about the date of the letter to Mr. Orton, Oct. 15, 1877, as it was provided with the rubber referred to in that letter, and I believe was sent for his approval. The instrument represented in Edison's Exhibit sketch, 121-12, corresponds with the carbon transmitting instruments produced here by Mr. Wiley and Mr. Prescott, with the exceptions of having handles. Edison's Exhibit sketch 110-12 represents a receiver similar to receiver No. 7 and 8, produced by Prescott, and No. 38 produced by Wiley, with the exception of the handle. The instruments produced by Prescott, and marked "Prescott's Exhibit, Edison's Iron Diaphragm Receiver," was made in Mr. Edison's shop. I believe, early in 1876, or about the middle of 1876, and as far as I can tell, remains unchanged. It was used as a receiver of musical sounds, such as singing. The instrument marked, "Prescott's Exhibit, Edison's Transmitter, brass tubes with mouth-piece and iron base," was made in the early part of the year 1877. I determine this date by Edison's exhibit, 130-11, which corresponds with Edison's Exhibit Instrument, 130-11, and also by Edison's exhibit sketch, 11-23, because I know that the said instrument produced by Mr. Prescott was made a long time previous to one of them being altered to an instrument, as shown in exhibit sketch, 11-12. This instrument is now in a condition for transmitting musical sounds, and has been sounded on numerous occasions.

Cross-examination by W. D. BALDWIN, Esq., counsel for E. Gray.

X-Q. 2. Please state what pecuniary interest, if any, you have in the subject-matter in controversy, and your present relations with Edison regarding electric telephony?

1000 : CHARLES BATCHELOR.

A. I have not the slightest pecuniary interest in the result of this controversy. All the money that I have received from 'the telephone' has been paid to me by Mr. Edison for work that I have done on the necessary experiments under his direction.

Cross-examination waived by counsel for Bell and Blaho.

CHAS. BATCHELOR.

1007

IN THE MATTER

of

The Interferences on Telephones:
THOS. A. EDISON, ELISHA GRAY,
A. G. BELL, and others.

Cases A to N, and
No. 1.

New York, Jan. , 1881.

1008 It is hereby consented by and between the counsel for respective parties to above named interferences that the deposition of Charles Batchelor, taken on Jan. 12, 1881, on behalf of T. A. Edison, be considered as taken

within the time allowed by the Patent Office for taking 1009
testimony on behalf of said Edison.

Cross-examination waived by me: J. J. S.

JAMES J. STORROW,

Counsel for Bell, Berliner & Blaho.

FRANK L. POPE,

For Dolbear.

BALDWIN, HOPKINS & PEYTON,

Attorneys for Gray.

GEO. W. DYER,

For Irwin and Voelker.

1070

GRIDLEY & CO.,

Attorneys for McDonough.

INTERFERENCE ON TELEPHONES:

THOS. A. EDISON, E. GRAY,

A. G. BELL, and others.

Cases A to N, and
No. 1.

New York, Jan. 10, 1881.

1071 In the above cases it is hereby agreed that the evidence of J. T. Murray may be taken at any time before the closing of the evidence in behalf of A. G. Bell. This arrangement is made in consequence of the sickness of said Murray. And it is understood that the conven-

1078 fence of counsel is to be consulted as to the time of taking his evidence.

F. L. POPE,

For Dolbear.

RAIDWIN, HOPKINS & PEYTON,

Attorneys for Gray.

JAMES J. STORROW,

Attorney for Bell and Blake.

GEO. W. DYER,

For Irwin and for Voelker;

Attorney of Record for Richmond.

GRIDLEY & CO.,

Attorneys for McDonough.

IN THE U. S. PATENT OFFICE.

IN THE MATTER

of

1074 The Interference on Telephones,
EDISON, GRAY, BELL, DOLBEAR,
McDONOUGH, RICHMOND, VOELKER,
IRWIN, and BLAKE.

Cases A to N, and
No. 1.

FEBRUARY 7, 1881.

Pursuant to consent it is hereby stipulated by and between the counsel for the respective parties to above

named cases, that the evidence of J. T. Murray, of New York, N. J., shall be taken in behalf of T. A. Edison at the office of L. W. Serrell, 140 Nassau street, New York, N. Y., on Thursday, Feb. 10th, 1881, at 11 o'clock A. M.; and said evidence shall be considered as taken within the time allowed for taking testimony on the part of said Edison.

The said Murray to be recalled for cross-examination, if required, within a reasonable time.

LEMUEL W. SERRELL,

Attorney for Edison.

JAMES J. STORROW,

For Bell and Blake. 1079

F. L. POPE,

For Dolbear.

GEO. W. DYER,

For Voelker and Irwin.

RAIDWIN, HOPKINS & PEYTON,

Attorneys for Gray.

GRIDLEY & CO.,

For McDonough.

1077

1078 JOSEPH T. MURRAY.

OFFICE OF L. W. SPURDELL,
140 NASSAU ST., New York, N. Y.
February 10, 1881.

Present—

L. W. SPURDELL, Esq., on behalf of T. A. Edison.
W. D. HALLJEW, Esq., on behalf of E. Gray.
J. J. SWANSON, Esq., on behalf of Messrs. Bell and Blake.

JOSEPH T. MURRAY, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Spurdell, Esq., as follows:

1079 1 Q. Please state your name, age, residence, and occupation?

A. My name is Joseph T. Murray, age 46 years, residence Newark, New Jersey, occupation telegraph instrument manufacturer.

2 Q. Are you acquainted with Thos. A. Edison?

A. Yes, sir; I first knew him in January, 1870, and up to the present time.

3 Q. Did you ever make any telephone instruments for him; if so, when first?

A. Yes; I made experimental instruments for Mr. Edison previous to getting an order for 100 instruments from him.

1080 4 Q. Please look at the telephone instruments here present, and state whether you made any of those instruments?

A. I made the transmitters and receivers which have heretofore been produced, having wooden cases, and they are marked "Prescott's Exhibit Edison's Carbon Transmitters Nos. 8 and 10" and the two receivers, marked "Prescott's Exhibit Edison's Magneto-Receiver No. 7 and No. 8."

5 Q. About when were these instruments made, and how do you fix the date?

JOSEPH T. MURRAY. 1081

A. I fix the date by an order given me by Mr. Orton, September 17, 1877, which is noted in my order book here present, and exhibited to counsel; also, from orders given by Mr. Edison to me calling for changes, and by his foreman, Mr. Batschelor. I produce here a paper dated Oct. 8, 1877, referring to changes that were to be made, and those changes were made by me; and one of those changes was a flut-holder, which I here produce.

(Counsel for Edison offer the paper in evidence marked "Murray's Exhibit, Oct. 8, 1877," and the device referred to marked "Murray's Exhibit, Edison's flut-holder.")

I also have a memorandum of alterations, dated Oct. 20, 1877, which I was ordered to make by Edison himself.

6 Q. Were these 100 instruments all made and supplied at once, if not in what manner?

A. No, sir; sometimes in pairs, and in different numbers as they were called for. Mr. Edison usually took them over. These were tested and slight changes made from time to time to make them more perfect. These instruments Nos. 8 and 10, are in the modified form. The changes spoken of in the order of October 20, 1877, have been made in these particular instruments.

(Counsel for Edison offers the paper in evidence, marked "Exhibit Murray alterations, Oct. 20th, 1877.")

7 Q. Please look at the Exhibit "Edison's Letter to Mr. Orton, Oct. 15, 1877," and state if you know what the instruments are that are referred to therein?

A. This relates to the sheet rubber that we used in these telephones, such as Prescott's Exhibits, No. 8 and 10. I had rubber diaphragms and had to supply the mica. I made the six telephones with the call bells ap-

1064 JOSEPH T. MURRAY.

ken of in this letter. I had the order for the 100 telephones before this letter of October 15, 1877. The changes that were made from time to time were a means of increasing the expense of these instruments above the contract price.

8 Q. In these instruments that were made pursuant to the first order from Mr. Orton what device was made use of to regulate the tension of the electric circuit in the transmitters?

A. It was regulated by pressure against this fluff. He put this plumbago in with the silk fluff. Mr. Edison put this in the instruments himself and adjusted them, down at his own place in Menlo Park.

1065 9 Q. Previous to October 8, 1877, had you, or not, received any direction for the manufacture of 100 of these telephone transmitters?

A. Yes, and was to work on them. I know this fact from the statement that is made on the Exhibit October 8, 1877.

10 Q. About how long a time was occupied in completing this order of 100, including the changes that were made to render the instruments more perfect?

A. The order was given September 17, 1877, and the whole of the instruments were made by me, and some were delivered from time to time to Mr. Edison; the balance of the order was delivered to Western Union, N. Y. The tension regulator was filled by Mr. Edison. These instruments were all delivered by me within two months from the reception of the order.

1066 11 Q. Are there any other instruments that have been produced in this case that you manufactured?

A. Yes; this instrument, here marked "Edison's Exhibit, Instrument, 120-11," was made by me; my name is on the front of it.

12 Q. About when was the same made, and how do you determine the time?

A. In July, 1877, I made four of them. I am able to determine this date by a drawing which I here produce, which drawing is dated July 9th, 1877, and I re-

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ceived it about July 11th, 1877, and went to work and got these instruments out as soon as possible. I saw these instruments tested in the Western Union Building. I find by reference to my order-book that these four instruments were ordered June 11, 1877, and shipped August 10, 1877.

Drawing offered in evidence, marked "Murray's Exhibit Drawing of Instrument 120-11."

And Murray's order-book referred to in last answer, submitted to Counsel for examination.

13 Q. In what manner did those instruments work? and what were they adapted to do?

A. They were built for telephonic purposes, so that two persons could correspond with each other from different places. On what wire they were tested, and at what distance in the Western Union Building, I can't say, but think from Philadelphia. I spoke into the mouth-piece at the end of the case, the diaphragm being at the other end of the tube, with a device for transmitting electric pulsations, and when receiving a message I listened at the same mouth-piece and turned a crank on the little disk at the side which revolved the small roller at the left hand of the machine, and fol along the electrically prepared paper. The friction vibrating the diaphragm at the side of the case to reproduce the speech transmitted. These machines were objected to on account of the cost. There was no other objection made to them that I know of.

14 Q. Do you recognize any other instruments as your make?

A. I made all the acoustic instruments that were practically used. The experimental instruments he made, I recognize "Edison's Exhibit, Leona Diaphragm" as my make. I made for Mr. Edison eight

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1000 JOSEPH T. MURRAY.

instruments similar to Mr. Edison's Exhibit, Instrument 149-13, but these instruments were rather larger and better made.

Adjourned for one hour.

G. L. P.,
Notary.

15 Q. When were these made?

1001 A. I find by reference to my order book that January 5, 1878, I received an order for the telephones referred to in my previous answer; the order was for twelve (instead of eight); I made twelve, and these were delivered February 11, 1878. These instruments were made to hold Edison's button of lampblack carbon, they were superior instruments, they worked practically. I know they were practically used between New York and Philadelphia within a few days of the time they were delivered. Mr. Bentley and Mr. Bucheler, I think, were at the other end, and also Mr. Phelps, Mr. Orton, Mr. Edison and myself were at New York. I have reason to believe that these instruments were as perfect transmitters as have been produced by any one since that time. I think Mr. Phelps' son was with us at the New York office. These instruments were of the class and general construction shown by "Edison's Exhibit, Instrument 149-13," but were larger and better proportioned. I don't know where any of these are now.

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Cross-examination by J. J. STROMBOW, Esq., counsel for Bell & Blazo:

16 xQ. When did you first make any speaking telephone?

A. I believe the instrument marked Edison's Exhibit Instrument 130-11; they were ordered June 11, and shipped August 10, 1877. It is the monophone.

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17 xQ. And the next after were the 100 ordered September 7, 1877, were they?

A. Yes.

18 xQ. And the next were the twelve ordered January 3, 1878?

A. Yes.

19 xQ. Have you ever made any others?

A. No; except that lately I have been experimenting for myself.

20 xQ. Please look at "Edison's Exhibit, Loose Diaphragm, September, 1877," No. 97, and tell me what the four little pieces that look like black paper stuck on with shalloe are, and what they are for?

A. Some of these pieces were rubber, on some instruments, and some pieces of thick paper. They were to raise the diaphragm off the cores of the magnet. That was the way of adjusting the distance between the cores and the diaphragm when the cavity was not bored quite deep enough. We put that on those that needed it, and did not on those that did not need it.

xQ. 21. Look at Prescott's Exhibit Edison's Magnetic Receiver No. 8, the little patch shalloe on the wood under the diaphragm in this instrument appears to be made of rubber, was that put there by you for the same purpose already mentioned, that is the adjustment merely?

A. Yes.

xQ. 22. Please look at your 10th X-answer; I understand from a remark you have just made that before 1025 June, 1877, you had done some experimental work for Mr. Edison; is that so?

A. Yes.

xQ. 23. And I understand also that the experimental work you so did for him before June, 1877, was on his acoustic telegraph; is that so?

A. Yes. I find in my order book the following order:

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"Dec. 14, 1876. Six acoustic instruments, six forks, two forks on bases."

Before that another order, dated Nov. 2, 1876, W. U. Co.

"2 acoustic instruments."

These were all practical instruments to be used on lines. I think that is the first of my permanent work, but I did experimental work for Mr. Edison on that before, of which I have no account.

xQ. 24. You and Mr. Edison were partners in business, were you not?

A. Yes; from July, 1872, to May 25, 1875.

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Cross-examination waived by Counsel for Gray.

J. T. MURRAY.

STATE OF NEW YORK, } ss:
County of New York,

I, GEORGE T. PINCKNEY, a Notary Public, within and for the County of Kings, (certificate filed in N. Y. Co.), and State of New York, do hereby certify that the foregoing depositions of Z. F. Wilber, Josiah C. Reiff, Edward H. Johnson, Robert Spivey, Charles Hatcher, Geo. M. Phelps, Jr., Henry Bentley, S. M. Plunk, Geo. B. Scott, G. L. Wiley, Geo. B. Prescott, Jr., and Joseph T. Murray, were taken on behalf of Thomas A. Edison, in pursuance of the notices hereto annexed, before me at 140 Nassau st., in the City of New York, in said County, on the 10th and 11th days of December, 1880, and the 4th, 5th, 7th, 8th, 11th and 12th days of January, 1881, and 10th day of February, 1881.

That each of said witnesses was by me duly sworn before the commencement of his testimony; that the testimony of each of said witnesses was written out by myself; that the opposing parties, E. Gray, A. G. Bell, G. B. Richmond, W. L. Volker, J. H. Irwin, and Francis Blake, Jr., were present by counsel (but J. W. McDonough, and A. E. Dolbear did not attend either personally or by counsel) during the taking said testimony.

That said testimony was commenced at 10 o'clock A.M., on the 10th day of December, 1880, was continued pursuant to adjournment, and was concluded on the 10th day of February, 1881; that I am not connected by blood or marriage with either of said parties, nor interested directly or indirectly in the matter in controversy.

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In testimony whereof, I have hereunto set my hand and affixed my seal of office at New York City, in said County, this 11th day of February, A. D. 1881.

GEORGE T. PINCKNEY,
Notary Public.

IN THE UNITED STATES PATENT OFFICE.

In the Matter of Interference
EDISON, DOOLBARE, GRAY,
BELL, McDONOUGH, RICH-
MOND, VOLKERS, IRWIN,
BLAKE, Improvement in
Telephones.

Cases A to N and
No. 1.

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New York, N. Y., April 22, 1881.
Geo. W. DYER, Esq.,
Atty. for Irwin, Volkors, & Richmond—

Sir:

Please take notice that on Wednesday, April 27th, 1881, commencing at eleven o'clock A.

1103 M., at my office, 140 Nassau street, New York, N. Y., and before a competent officer, I shall proceed to take the testimony of the following witnesses, as rebutting evidence in behalf of said T. A. Edison : Charles T. Hughes, 65 Fifth avenue and D. W. Ollison, 116 Walker street, New York, N. Y. Martin Force, Monlo Park, N. J. Ira S. Kinch, Albany, N. Y., and T. A. Edison, of 65 Fifth avenue, New York, N. Y. The examination will be continued from day to day until completed. You are invited to be present and cross-examine said witnesses.

LEMOUEL W. SERRELL,

Atty. for T. A. Edison.

1103 Service of a copy of foregoing notice acknowledged this 25th day of April, A. D., 1881.

GEO. W. DYER, for Voelker & Irwin.

GEO. W. DYER, Atty. of Record for Richmond.

FRANK L. POPE, for Dolbear.

J. J. STORROW, Counsel for Bell & Blake.

† BALDWIN, HOPKINS & PEYTON.

Attys. for Gray.

GRIDLEY & CO.,

Attys. for McDonough.

IN THE UNITED STATES PATENT OFFICE.

Before, Hon. Commissioner of Patents, in the Matter of the Interferences on Telephones:

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EDISON, BELL, BLAKE, GRAY,
DOLBEAR, IRWIN, RICH-
MONSIE, McDONOUGH and
VOELKERS.

Cases A to N and
No. 1.

Deposition of witnesses examined on rebuttal in behalf of T. A. Edison, pursuant to annexed no-

1105 tices at the office of L. W. Serrell, 140 Nassau street, New York, N. Y., on Wednesday, April 27, 1881, at eleven o'clock, A. M.

Present:

L. W. SERRELL, Esq.

On behalf of T. A. Edison.

W. D. BALDWIN, Esq.,

On behalf of E. Gray

J. J. STORROW, Esq.,

On behalf of Bell & Blake.

Col. G. W. DYER,

On behalf of Messrs. Irwin, Voelker & Richmond.

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Counsel for Edison produces the original "Translation by W. U. Translator of Reiss' Telephone," and states that he deems it proper to state that it has become injured : That he furnished it to C. B. Merwin for the purpose of printing the descriptive portion ; that while in said printer's hands some person had partially cleaned, apparently with rubber, the sheet on which the pencil sketches were made and rubbed out some of the lines ; and that he had taken the affidavit of Mr. Merwin showing that this had occurred while the paper was in his hands. Counsel makes this statement on the record so that the present condition of the original may be accounted for.

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1108 EDWARD H. JOHNSON.

OFFICE OF L. W. SERRELL,
140 NASSAU ST., NEW YORK, N. Y.,
Wednesday, April 27, 1881.

Edward H. Johnson, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Have you before given your evidence in these telephone interferences known as A to N and No. 1.

A. Yes; I have.

2 Q. I now call your attention to x-Q. 18 of A. G. Bell's deposition, in which he is asked whether he discovers any substantial difference in the instruments themselves shown in Edison's application Nos. 148, and figs. 2 and 3 of the Bell Patent, 188,787, and Mr. Bell, instead of answering the question, volunteers the statement that Mr. Edison's instrument is made to "respond forcibly to some particular pitch of sound only;" please state whether or not that statement made by Mr. Bell is correct.

1110 Objected to by counsel for Bell, on the following grounds:—That this is not competent testimony in rebuttal; that it does not relate to any matter put in evidence in behalf of Bell; that the question was gone into in Mr. Edison's evidence in chief; that the said x-Q. 18 to Bell was put by counsel for Edison, and related to matters on which Mr. Bell was not interrogated on direct examination, and that counsel for Edison cannot, by asking incompetent questions, lay the foundation for incompetent rebuttal; that, having interrogated Mr. Bell, upon matters not opened

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on Bell's direct examination, he made Bell his own witness, and was bound by his answers, and because the testimony sought to be drawn out by the question tends to contradict the evidence in chief put in by Mr. Edison.

Counsel for Bell moves that the question, and any answer that may be made, and any testimony bearing on the subject, which may be introduced be not considered, but disregarded and struck out, and gives notice that he shall call such motion up for hearing on the day of hearing of the case.

Counsel for Edison replies, 1st, that no objection was made to said X. Int. 18 at the time it was put; that it should have been made at that time if the question was incompetent.

2nd. That it was only necessary for the witness to answer the question "Yes" or "No," as he did afterwards in reply to X Int. 20; and that if instead of doing so he gives his own views on the subject, it is competent to show whether those views are correct or not.

Counsel for Bell calls attention to the fact that the interrogatory referred to was in the usual language adopted in questions to expert witnesses, and asked the witness to compare two things and also to the fact that no part

of the answer was objected to as irrelevant, and that the question called for Mr. Bell's opinion as an expert

with relation to a contesting instrument of Mr. Edison's not referred to in Mr. Bell's testimony, and the character of which it was Mr. Edison's business to prove, and which he had already introduced in testimony upon, and that the question to Mr. Bell was intended, not to disprove his case, but to prove Edison's.

Counsel for Edison replies that the Cross Interrogatory 19 calls attention to the fact that the witness had not answered the question, and notwithstanding that, it was not until cross Interrogatory 20 that a direct answer could be obtained.

A. No; it is not correct. The telescope arrangement of Mr. Edison's instrument operates in fact to increase or diminish the volume of sound, as the tube is lengthened or shortened. Whether the instrument responds forcibly to any particular sound is something I could only determine by actual experiment. What I do know to be the fact is, that with the instrument in question any and all tones are clearly brought out.

Q. Please state what, if any, experiments you have made, or upon what the opinion you have expressed is founded?

Same objection motion and notice.
Same reply.

A. The experiments which I have made personally have been in the direction of reproducing, on these instruments, articulate speech, singing, and I find no marked difference in the various tones used. In the early experiments made by Mr. Edison, in which I assisted, my recollection is, that these instruments failed to respond to any particular tone exclusively, but gave equally well all tones. These were the experiments conducted in Mr. Edison's Laboratory at Newark, about which I have previously testified in these interferences.

Q. Have you made any tests with either the instrument A. or A', or any duplicate of either, and can you demonstrate whether or not either instrument, A. or A', is capable of receiving articulate speech?

Same objection and motion.

Same answer.

A. I have made such experiments with duplicate of these instruments, and am prepared to demonstrate here, at the moment, that they act as very good receivers. The articulation being clear and distinct.

Q. Now, will you please, for the information of the counsel so connect the instrument A', and test it in the manner spoken about?

Same objection as before, and further objection that the counsel are neither judges or witnesses.

A. I have connected up the instrument, Exhibit A', as a receiver, with an Edison Carbon transmitter, and find it, although in a very damaged condition, it being necessary to hold the diaphragm on with the fingers, sufficiently effective as a receiver

to reproduce the words in a distinct and audible manner. As to the effect of the length of the tube on talking, I hold that the main, and perhaps the only effect that it has is to take up the local sounds in the room and echo them back on the ear, thus, in a measure destroying the quiet that is of importance to any receiver, but in addition to increasing the local sounds, the tube increases the volume of the telephonic sounds, so that the proportion of one or the other remains about the same.

6Q. Interference No. 1 relates to "a spring forming "carrying one electrode of a circuit of a telephone "and constantly pressed against the other electrode "and a diaphragm to maintain the required initial "pressure between the electrode, and yield to the "movement of the diaphragm."

Have you made any experiment to determine whether or not an instrument with a yielding electrode is the best form for general business purposes, or whether it is preferable to employ a rigid electrode in connection with the diaphragm?

Counsel for Voelker and for Irwin objects to this question and whatever answer may be made to it upon the ground that Voelker and Irwin first took their testimony and Mr. Edison subsequently took his testimony at great length in reply, and so far as relates to Voelker and Irwin, this is in no sense rebutting testimony and objection will be made and motion at the hearing to have it struck out or not considered so far as relates to Voelker and Irwin.

Counsel for Edison replies that Messrs. Voelker and Irwin have still opportunity to take their rebutting evi-

dence, if they desire, and that Edison's rebutting evidence is not limited to any particular time or subject, he being entitled to take at this time *any* rebutting evidence.

A. I have made very exhaustive experiments with the express purpose of determining this point, and have satisfied myself, as well as many others, that the yielding spring is not only not required, but is an actual detriment to the transmitter itself. The most perfect articulation, combined with the greatest volume, is obtained from a transmitter with an unyielding support to the carbon. I was led in the first instance to recover the ground which I had already traversed with Mr. Edison, and determine for myself whether in abandoning the yielding spring

Mr. Edison had done the right or the wrong thing by the successful introduction of transmitters with yielding springs, and the frequent expression of opinion which reached me, that the yielding spring arrangement was superior to the non-yielding. I became interested in a manufactory of telephones, and was ambitious to produce the best form of Carbon Transmitter. I have tried upwards of 500 different arrangements of the mechanical part of the transmitter, and have invariably failed to produce anything with a yielding support, at all comparable with the arrangement finally adopted by Mr. Edison. I am familiar with every form of carbon transmitter in use, and can testify without hesitation from actual experience with them that they fall far below the Edison arrangement in the chief function of a telephone transmitter, viz:—

To reproduce as nearly as possible in clearness of articulation, volume, and quality, the voice of the speaker without suffering derangement.

7 Q. Please point out which of the exhibits in this case you consider to be the most perfect for the purpose of transmitting articulate speech?

A. Exhibit marked "Exhibit Edison's Carbon Telephone, S. L. 03" (Page 541 of vol. 2, of the record), "Edison's Exhibit, Microphone," on page 545, same vol., shows the same character of transmitter modified only by the changing of the adjusting screw from the back of the transmitter to the front through the diaphragm; the object of this change is twofold; first, that the support at the back of the carbon instead of being upon the end of the adjusting screw, could be solidly and permanently fixed in the body of the case, and therefore be more rigid than when attached to the screw.

1117 2nd. It offers the opportunity of more readily adjusting and maintaining the adjustment of the instrument.

Exhibit, Bentley No. 3, page 536, same vol., is the same thing as "Edison's Carbon Telephone Ex.," in a different case.

8 Q. In answer to Int. 6, you speak of Mr. Edison abandoning the yielding spring; what do you mean by the expression, and what led to this?

1118 A. Mr. Edison's earliest form of transmitters invariably contained a yielding spring in some form or other, and about the time that he was introducing this invention to the attention of the Western Union Telegraph Company, he made a series of experiments to determine what tension of spring gave the best results. He soon found that as he increased the stiffness of the spring the results became more favorable. This led him to gradually increase the tension until he had made one in a spiral form of steel, 1-16 of an inch square, and having but two turns or thereabouts. This he nat-

urally considered did not yield to the vibration of the diaphragm at all, and as the results were so far superior to the lighter forms of springs used, he jumped to the conclusion that a rigid support was the correct thing. An experiment made in a few minutes determined this unquestionably, and no experimentation yet made in the telephone field by any one has resulted in the production of a transmitter of such uniform excellence as the one then and there made on this principle. The principle of the carbon transmitter is to cause a compression upon the surface of the carbon, the force effecting this compression being sound waves set in motion by the voice; this force is necessarily of a varying degree and of a limited power. The first requirement of the transmitter is, therefore, that this weak force shall produce the maximum compression on the carbon, and thus insure maximum variation of the resistance, and in consequence the greatest volume of sound in the receiver; it may be readily demonstrated that with a given force exerted upon a non-yielding object, a greater compression is obtained than when the same force is exerted upon a yielding object. There is also another important object in having the support non-yielding, it is this: to transmit articulate speech, it is as necessary that the electric wave should be as unbroken and continuous as the sound wave. If the contact between the platinum and carbon points or surfaces are allowed to separate for however an infinitesimal period of time the continuity of the current is broken, the flow of the current is interrupted, and the sound wave is not reproduced at the distant end. Now in all forms of transmitters having yielding supports, this interruption takes place whenever the sound waves falling upon the diaphragm attain a force beyond that for which the spring is particularly adjusted. The practical effect of this is to require that the person

speaking in the instrument shall either so regulate his voice, or the distance from the diaphragm at which he speaks, as to effect upon the diaphragm the requisite uniform degree of pressure. Failure to do this results inevitably in the separation of the contacts and the consequent failure to transmit the words. A derangement of the instrument also results from such separation of contacts by virtue of the fact that the electric spark resulting from such separation effects a deterioration of the contact points, thus rendering the instrument less efficient and sometimes wholly inoperative. These results cannot occur in the rigid support arrangement devised by Mr. Edison, and it was precisely because of this fact that Mr. Edison abandoned the yielding spring and adopted the rigid support. What I mean by the word "abandoned" is simply that he ceased to apply it to the instruments furnished to the public.

1132 Q. If instruments of the general character of the Blake transmitter, and instrument such as Edison's Exhibit Carlson Telephone, were presented to the public, which would usually be selected or preferred by customers?

1134 A. The Blake or similar microphonic arrangement for the reason that there is a certain fascination in speaking at nothing particular, and still having your words transmitted to the distant listener, while there is an aversion against speaking into a mouth piece, as if speaking into a speaking tube, and as these are practically the requirements of the two arrangements, the Blake transmitter has come to be more popular. The people neither know or concern themselves as to which is the best for the effectiveness of the system. Another reason why this form has come into more general use than Edison's arrangement is, that by the consolidation of the two companies, the Edison and the Bell, the parties owning the Blake arrangement obtained control

and being interested in its adoption, it was natural by given preference.

10 Q. If instruments in which the electrodes are pressed together by springs, such as the so-called Blake instrument, were offered to the public in the same manner as the Edison Carlson Transmitter, which one would be the best for general business purposes, after thorough test, in your judgment?

A. The Edison, unquestionably, for the reason that its margin of adjustment is so great that a conversation may be carried to its conclusion between any two individuals without regard to any variation in the strength of their voices; and the current from such transmitter being so much stronger than from the other arrangement, such as the Blake, the constantly varying electrical conditions of the wires, as they actually exist in practice, are always effectively met and overcome, while with the Blake any slight adverse condition presents an effectual barrier to conversation. The Telephone Exchange employees, not hearing any conversation, conclude that it has terminated, and frequently separate the two talking parties ere the conversation is finished.

11 Q. Will the tube E, in the Bell patent 186,787, act in a similar manner to the tube in Edison's Exhibit A?

Same objection as to Int. 2.

Same answer.

A. In a similar manner; the diameter of the tube is the only difference.

12 Q. Is the statement made in the last clause of the answer to X Int. 26 in Mr. Bell's deposition correct?

Same objection as to Int. 2.

Same answer.

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I A. I deny the statements made by Mr. Bell that magneto instruments could be used as transmitters upon the circuits as now arranged; for the reason that they are not capable of creating a current of sufficient strength to overcome the adverse conditions constantly existing on these circuits; such, for instance, as the inductive effects derived from adjacent telegraphic and other circuits. It is a notorious fact that the early attempt of Bell to introduce his magneto telephone for exchange purposes in large cities, as well as all subsequent attempt of other parties to do the same thing, have proven signal failures. No success approaching a practical character was made until the carbon transmitters were adopted.

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The owners of the Edison carbon instruments were the first to make a practical and commercial success of telephonic exchange, and their success compelled the owners of the Bell magneto device to experiment for and ultimately bring into use a carbon telephone transmitter, viz: The so-called Blake arrangement. From that time their efforts to establish exchanges have been crowned with success. A similar experience has been had by certain French parties who modified the magneto apparatus in such way as to render it much more effective as a transmitter than Bells, and who made extraordinary efforts to introduce it in the City of Paris and in England. In the City of Paris, owing to the particularly favorable conditions existing there, a modicum of success was obtained. Elsewhere the thing was a conspicuous failure. The magneto instruments create and transmit to the line electrical currents by the motive power of the voice acting upon the diaphragm, and are necessarily limited to the effectiveness of such power.

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The carbon transmitters simply *control* currents which are generated in a battery in the ordinary manner, and by a variation of the conductivity of a

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circuit of very low resistance, convert a current of low, in one of exceedingly high tension and of a strength very much in excess of the magneto currents. The proof of the superior strength and efficacy of the battery currents, is to be found in the fact that they are in universal use; whereas, it is very rare to find a magneto used as a transmitting current generator or transmitter. And the fact, notorious today to all users of the telephone, that even the carbon transmitter is hardly able to render the conversation at all time sufficiently distinct, is a sufficient denial of Mr. Bell's position, that the magneto could be used on the circuits as they exist. A magneto instrument, when newly magnetized, is very much more effective than when it has been in use some time; this is due to the fact that the steel composing the core of the magnet is necessarily saturated with magnetism, which surplus is not unlike a glass over full of water, as when its edges have been greased and the water raised above their level, a slight shock to the steel will cause the extra magnetism to overflow and escape precisely as a similar shock to the glass would discharge the surplus of water; from this fact it is apparent that when such a magnet is used on a transmitter and is constantly subjected to the powerful molecular disturbances produced by the powerful vibration of the diaphragm under the direct impact of the voice, an effect precisely analogous to striking the magnet with a hammer is obtained, the result being a very decided loss of magnetism and a consequent loss of effectiveness as a current generator or transmitter. This is the explanation of the fact that magneto transmitters, when new, give so much better results than a little later on in their life. The statement that "If the magneto instruments now in use as receivers were to be removed from the circuits where they are now employed, the whole telephonic communication of the coun-

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"try would become disorganized," is so totally at variance with the facts, that I fail to understand how it could have been made. In point of fact, all that would be required in case of such removal, would be to substitute the magnetograph receiver of Mr. Edison. The proof of their efficacy as receivers lies in the fact that a company was formed in England for the introduction and practical use of just such an arrangement as this substitution would make, and many hundred of these instruments were practically operated, and in such an efficient and satisfactory manner as to constitute the exchanges using them, the most effective of any as yet in operation in England, or as far as I know in this country, and were in position to make use of them, with Mr. Edison's Carbon Transmitter, I do not hesitate to say that I could speedily create a competitor to the present system, which would in a very brief time outgrow in proportions and in efficiency that which Mr. Bell testifies would become disorganized, if the magneto was removed, and in doing so I would not use a single magneto receiver. Mr. Bell must be aware of these facts, as in the Pooling of the Edison and the Bell Companies, in England, his associates gave to the Edison Co., which did not use a magneto, £115,000. A consideration of this character would hardly be paid to a "disorganized" and inoperative competitor.

1140 Adjourned to Thursday, April 28, 1881, at 11 o'clock, A. M.

GEO. T. PINKNEY,
Notary Public.

THURSDAY, April 28, 1881.

Met pursuant to adjournment :

PRESENT :

L. W. SIBBELL, Esq., for EDISON.
W. D. BALDWIN, Esq., for GRAY, and
COL. G. W. DYER, for VOLKER and HEWES and
RICHMOND.

Examination of E. H. Johnson, by L. W. Sibbell, Esq., continued :

1143 Q. Mr. Watson, in answer to X. Int. 77, says that he has not known of a Blake transmitter being injured by an electric spark passing, when the electrodes were separated; have you any knowledge on this subject, if so, what?

Same objection as to Int. 7.

Same answer.

A. Yes; I have known such cases, having observed that transmitter failed to respond favorably. I examined it and found an oxide had formed on a plating electrode, which oxide being a parallel non-conductor prevented electrical contact between the platinum and the carbon. When removed, the instrument would again be in working condition. Several cases of this kind have come under my observation—due in particular, I remember well, as having occurred in the executive offices of the Bell Telephone Company in London, where I showed the chief engineer the difficulty with his instrument, and pointed out the fact of the presence of this non-conducting oxide. This fact was not known to anyone connected with that company, and is not, I believe, generally known to those who have charge of these telephones.

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14 Q. Is any such difficulty likely to arise in the Edison Carbon Telephone, if not, why not?

Same objection as to Int. 2.

Same answer.

A. No. For the reason that the electrodes never separate, there can therefore be no spark to form this oxide, besides which the surfaces in contact are so much larger, that even in case of improper adjustment, permitting of a separation of the electrodes, there would not be sufficient effect at any one

1151 point to produce an oxide.

15 Q. Referring to the various telephones that have been made by Mr. Edison, from time to time, commencing with his use of plumbago upon an oil stone, and going through the various instruments employed by him in which the electrodes have been carried by springs, and springs have been applied between the diaphragm and the carbon, state whether or not the carbon itself has performed the same duty in connection with the electric circuit from the first to the last?

Objected to by counsel for Mr. Bell, as not relating to matter competent in Rebuttal.

1152

Counsel for Edison replies that the relative merits of the different instruments could not be shown until the character of each had been shown by the direct evidence; neither could the differences in the modes of operation be pointed out.

A. Precisely the same, the principle upon which carbon telephone operates has not changed, simply

EDWARD H. JOHNSON. 1153

because it is better understood to-day than when first discovered. It is an open question yet whether or not the variation of resistance is wholly on the surface of the carbon at the point of contact, or whether it is not in addition thereto, between each of the carbon atoms. Mr. Edison at first thought that the action was between the atoms of carbon primarily, but upon trying a piece of hard carbon he became satisfied that a considerable percentage of the variation of resistance was upon the surface. A new difficulty, however, presented itself at this point, which operated as a barrier to the use of the rigid carbon, viz.: Preventing the absolute separation of the carbon and platinum under the force of the vibration of the diaphragm. This led to a continuation of the use of a yielding spring in some form, or other; sometimes it was purely external, and sometimes it was made a component part of the carbon itself, as when a piece of rubber tube was canted with carbon, or an elastic carbon was made of fibre and plumbago. In all these experiments the principle remained the same; it was simply a perfect mechanical arrangement for obtaining maximum variation of resistance, without incurring absolute separation of the electrodes, that Mr. Edison was seeking. His first instruments were microphones; they became telephones only by gradual stages of development. A microphone, being nothing more or less than a telephone transmitter of such excellent delicacy of adjustment as to be imperceptibly delicate of adjustment of the voice. Such microphone becomes a telephone without other change than an adjustment offering a greater compression of the parts, so as to permit of their stronger vibration without separation. The microphone is intended to respond only to vibrations of such minute

character as to be impervious to the unassisted senses. A telephone is the same thing adjusted to respond to the stronger vibrations, such as the voice. At the time of the controversy as to whether the microphone and the earless telephone transmitter were one and the same thing, there was but one man in England who expressed the opinion that they were identical in principle. That man was Sir Wm. Thompson, and when I sought in England to obtain the testimony of others to this effect, I found but few willing to endorse Professor Thompson's view. Now I find it is even quite more difficult to find in England a scientific expert who differs from the opinion of Prof. Thompson, thus showing that at the time Mr. Edison's discovery was announced the principle was not understood, and now that it is understood, every one can see the microphone and the telephone are identical in their principle of operation. On recently visiting England in March last, I found that this change had taken place in the minds of scientific men.

10 Q. In what light do you regard the instruments of Mr. Edison, in which the electrode was sustained by a spring. I mean on the question of the instruments being perfect or imperfect, successful or unsuccessful, at the various times when they were made, tested, used, and publicly introduced?

A. Each modification of the spring gave results 1158 so satisfactory, that it was a common expression at Menlo Park that this was certainly perfect. The instruments would be taken to New York and tested on the wires, when some question of still more perfect adjustment would arise. This went on, step by step, until finally the springs were eliminated altogether, and the question of difficulty of maintaining adjustment was definitely disposed of. Mr. Edison was not satisfied with an instrument which would allow of the circuit being broken under varying strength of voice; otherwise the in-

strument which would have gone permanently into use, would have been the present microphone arrangement of Blake and others. It was his dissatisfaction with this feature which led him to lay aside from time to time the various spring devices, and to ultimately reach the rigid support device.

17 Q. At the respective times when the Edison instruments were made containing one or more spring-carried electrodes, was there or not any telephonic device publicly known or in use better adapted to the desired purpose than these respective instruments?

A. There were none of any description. Other inventors had not yet become cognizant of the principle Mr. Edison had discovered. No other principle has yet been discovered of a practical character?

18 Q. Please look at the patent of A. C. Bell, No. 174,405, and state whether or not you discover therein any information or statement by which you, as an electrician, would know how to transmit or receive articulate speech?

A. I see nothing in the patent which would have suggested to me at the time of its issue a device for the transmission of articulate speech. It appears to expressly forbid the transmission of the composite tones which form articulated words by the articulated assertion that the instruments will not respond except to a particular vibration. Of course, in the light of the present day, it suggests a modification which would render the transmission of words practical. As it evidently did not suggest such a thing to the inventor himself, I am of the opinion that it would not have suggested it to me.

19 Q. Please refer to the claim in Bell's patent 186,787, and state whether or not the subject of these claims is found in the instrument shown in figure 2 of Edison's application 118?

1162 EDWARD H. JOHNSON.

A. In all except the eighth claim they are absolutely identical, and in that they differ only in the substitution of a permanent for an electro magnet.

20 Q. So far as the devices themselves are concerned, do you find anything in the said patent of Bell 186,387 that is not represented in the application of Edison 148?

A. No, except as before stated in figures 5 and 6, where a permanent magnet is substituted for the electro magnet.

21 Q. State whether or not the instruments represented in fig. 2 of Edison's Application 148 are adapted to use as transmitters, and whether or not such instruments will actually work as transmitters, and in answering you may have reference to Edison's Exhibits A and A', and whether or not the instrument shown in figs. 1, 2 and 3 of Bell's Patent 186,387, have any advantages over the Edison instruments before referred to in this question?

A. The instruments fig. 2, Edison's case 148, are adapted to act as transmitters, and will so act. Figs. 1, 2 and 3 of the Bell patent are identical to those referred to in the Edison case, and will act with neither more or less efficiency. I have tried the instruments, Edison's Exhibits A and A', both as transmitters and receivers, with the results that he words spoken into the one are distinctly and tangibly reproduced by the other, and with the instruments in the condition in which they now are.

1164

Adjourned to Friday, April 20th, 1881, at 11 o'clock A. M.

GEO. T. PINCKNEY,
Notary Public.

EDWARD H. JOHNSON. 1163

FRIDAY, April 29, 1881.

Met pursuant to adjournment.

Counsel present as before.

Examination of Mr. E. H. Johnson, by L. W. Serrell, Esq., continued.

22 Q. Please state what the action will be, electrically, when employing a magnetic transmitter and receiver in one instance with permanent magnets, and in the other instance with electromagnets, and compare the electric operations of the same with a telephone having a battery power equal to that used with the electromagnets, and in which instance the electrodes are liable to separate and to separate when employing such telephone?

Objected to by counsel for Bell, because it does not relate to any issue raised.

Counsel for Edison makes the same reply as at end of Int. 13.

A. When a transmitter and receiver having permanently magnetized cores in lieu of a battery, are used together, the action is as follows: When at rest, we will say that the diaphragm of the receiving instrument is attracted by its magnet with a force equal to 50, to use an arbitrary figure. If now, the transmitting diaphragm is forced forward, towards its magnet, an electrical current will pass to the helix of the receiving instrument, and act to re-enforce, or to reduce the magnetism of the permanent magnetized bar, we will say that it is of the newly magnetized bar, we will say that it is of the same polarity, and therefore re-enforce the power of the magnet. The effect on the diaphragm of the receiving instrument will be as follows: As I have

1167

stated, it is already under tension from the unit of force (50); this we will say, has been augmented by 25, by the action of the current. We therefore now have the diaphragm under tension of a force of 75, or in other words, it is drawn closer to the pole of the magnet, and therefore further out of a true plane. Now, we will suppose the diaphragm of the transmitting instrument, in performing its natural vibratory movement, in response to the voice operating it, has commenced to recede from its forward position, thus, at the same instant, a current of the opposite polarity is set up and transmitted to the receiving instrument, and a two-fold effect is produced thereon.

1169 1st, The augmentation of the power of the permanent magnet by 25 is lost, and the nominal power of the permanent magnet of 50 is neutralized by the current, none of contrary polarity equal to 25, thus leaving the diaphragm subject to a tension of a force of only 25. The change of tension, from 75 to 25, permits of a derelict reaction of the diaphragm. The condition of the current in the line during this operation will be rising from zero to a strength of 25, and falling again to zero, with the current flow in one direction and rising from zero to the strength of 25, and falling again to zero with the current in the opposite direction, with the result of an absolute break in the continuity of the

1170 current at the zero line. The effect of this break in the continuity of current on the diaphragm of the receiving instrument is however nil, for the reason that its occurrence is exactly coincident with the change from condensation to rarefaction in the sound waves, and does not therefore mutilate the sound wave reproduction by the receiving instrument, either by a failure to form it entire, or by the introduction of any extraneous or false vibration. For all intents and purposes we therefore have a force affecting the receiving diaphragm

which is the precise representative of the sound wave actuating the transmitting diaphragm. In the case of the use of electro magnets, that is to say, soft wire cores in the helix magnetized by a battery current, I will assume that the battery current is of sufficient strength to magnetize the cores of the instruments with the same degree of magnetic strength as was possessed by the permanent magnets in the case just described; or, in other words, that the electro magnets exert a force of 50 on each diaphragm, the action will be analogous to that of the permanent magnetic arrangement above described, in every particular: the condition of the current on the line will, however, differ in this respect while in the permanent magnetic arrangement there is a point when no current passes, in the electro-magnetic arrangement there is no such point, as the current from the battery which magnetizes the cores of the magnets is of necessity of greater strength than the current of opposite polarity generated by the transmitting diaphragm in moving in one direction, and therefore cannot be wholly neutralized by this opposing current. The practical difference is one simply of degree of change of polarity; in the permanent magnetic arrangement the change is more decided than in the electro-magnetic, and therefore the effect on the diaphragm is somewhat greater. In the case of a make and break or airtelle contact transmitter, we 1173 have a different condition. We will assume that the contact points are together, and the current strength passing on the line and therefore actuating the receiver, is equal to the production of a magnetic strength precisely the same as in the two cases heretofore cited. The sound wave falling upon the transmitting diaphragm, and forcing it forward, effects a greater compression between the contact points, which greater compression is instantly followed by a reaction, arising from the elasticity of

the metallic points and resulting in the actual separation of these points (the ordinary effect of convection). This separation occurs when the current strength should be at its maximum, and the contact is not restored again until the diaphragm has reached a point in its recession when the current should be again at its maximum; thus we have a break in the continuity of the current, abruptly made, at a time when the sound wave is decreasing in its strength, and not restored until it has again attained its maximum of contrary movement. This break in the continuity of the current effects

an abrupt termination of the magnetism in the receiving instrument, and a consequent sudden release of the diaphragm from all tension, the result of which is the abrupt cessation of the work of reproducing the sound wave and its consequent loss, which cessation is also accompanied by the false sound wave engendered by the diaphragm's sudden release from tension and its restoration to its normal position; the effect is simply to substitute a sound wave entirely of local formation and having nothing in common with that given motion by the valve actuating the transducing instrument, for the true wave lost by the failure of the current wave. This break in the electrical wave is of greater or less duration, according as the initial pressure upon the

contact points in the transmitter may be greater or less, but in case it is reduced to a minimum, we have the opposite action, viz.: a constant flow of a current of one strength, and a consequent failure to form an electric wave at all, and a failure to actuate the diaphragm of the receiver, thus, whether the contact points separate or remain closed, we have but one practical result, viz.: a complete failure to effect a rise and fall of the electrical tension in harmony with the tension of the sound wave.

Adjournd for 30 minutes.

G. T. P.

I have assumed for the purpose of my illustration of the effect of a break of the current that an electric wave was partially formed when the points where in actual contact. In point of fact no such partial formation can take place by the use of metallic contact points; except some substance foreign to the metal composing these points, is introduced between them.

If we have an adjustment of these contacts which approximates as nearly as possible to that required for the formation of an electrical wave, such for instance as would be had in case of carbon or other effective substance was used for one of the electrodes, then we have a relation of the parts, one to the other which would ensure an absolute break for each and every vibration of the diaphragm; or in other words, a perfectly adjusted transmitter, capable of responding to and creating an electrical pulsation for every previous vibration of the air wave, *but not* capable of connecting them together in the continuous manner and of the variable degree of strength requisite to give to the electrical current the form and continuity of the sound wave. This fact is explained by the fact that the density of the two metal contacts is so much greater than that of the air, that when they are compressed they will separate much more rapidly than will two particles of air. Hence we have the following action: a power is applied to the air to condense it—it in turn compresses (through the medium of the diaphragm) the two metal contacts, they then by virtue of their superior elasticity separate more rapidly than do the air particles, the result being a lack of harmonious movement and a consequent absolute separation of the points resulting in a break in the electric circuit. 29-Q. Is it possible therefore to make a telephone operative where the electrodes are nothing but metal points?

1189 IRA S. KINCH.

A. It is not possible.

EDWARD H. JOHNSON.

Adjourned subject to the witness being recalled for cross-examination by counsel for Bell.

GEO. T. PINCKNEY,
Notary.

OFFICE OF L. W. SORRELL,
140 Nassau St., New York, N. Y.
Wed., April 27, 1881.

1181

IRA S. KINCH, being duly sworn deposes and says in answer to interrogatories proposed by L. W. Sorrell, Esq., as follows:

1 Q. Please state your name, age, residence and occupation?

A. My name is Ira S. Kinch; I reside at Albany; New York; occupation, Telegraph Superintendent, 34 years of age.

2 Q. State about how long you have been in that business?

A. Two years for the New York Central R. R. Co.

3 Q. In what business were you engaged in before?

1182

A. Telegraph operator and office inspector.

4 Q. What, if anything, have you had to do with telephones, and where?

A. I was superintendent of the Commercial Telephone Company of Albany from June, 1879, until February, 1880.

5 Q. What instruments were used by the Commercial Telephone Company while you acted as its superintendent?

IRA S. KINCH. 1183

A. The Edison transmitter and receiver, both; we used the penny crown Blake receiver.

6 Q. What was the character of the Edison transmitter that you used?

A. The carbon transmitter which we used was sets that were supplied, called the universal sets. The transmitter was such as the instrument here present, marked Edison's Carbon Telephone.

7 Q. About how many of such Edison carbon transmitters were used?

A. About 700.

8 Q. Did those carbon transmitters give satisfaction or not?

A. They did.

9 Q. For what period of time were such Edison carbon transmitters in use, to your knowledge?

A. To my knowledge, ten months.

10 Q. Was any other transmitting instrument presented to the public, to your knowledge, at Albany during the time you were superintendent?

A. Yes, sir; the Blake transmitter.

11 Q. To what extent was that introduced, as far as you know?

A. About 25 while I was superintendent.

12 Q. Have you any knowledge as to the relative merit of carbon instruments such as exhibit Edison carbon telephones and instruments in which one electrode is held by a spring, so as to yield to the motions of the diaphragm?

A. I have had the most experience with the Edison instruments, and have made a great many tests with the Blake. The principal tests I have made have been made in noting the quality of the voice that in my experiments the Edison transmitted the quality of the voice perfectly. The tests I made were on different lengths of lines, from a quarter of a mile to 229 miles, between Albany and Rochester.

1185

1186 IRA S. KINCH.

12 Q. If there are any difficulties experienced in connection with telephone transmitters in which one of the electrodes is upon a spring, state what the cause is, if you know it.

A. There are several causes that I have not with, a greater liability of getting out of adjustment; another is that they don't work as well when the battery is weak, and they are disturbed more easily by outside noises and induction. They do not transmit the quality of the voice so perfectly as the Edison transmitter.

14 Q. Have you had opportunity to ascertain which transmitting instrument is the most improved 1187 by persons who have tested them by long use and under various circumstances?

A. The majority of the people that I have talked with who have used both, prefer the Edison, for the reasons which I have before given.

15 Q. Do you know whether the Bell Company is supplying the Edison instruments as called for by its agents or customers, or whether there is any delay in supplying the same?

A. I don't know of my personal knowledge, but have been told by the employees of the company that there is delay in getting the instruments.

Objected to as a mere hearsay of hearsay.

1188

IRA S. KINCH.

OFFICE OF L. W. SEIBRELL,
140 Nassau Street, New York, N. Y.,
Wednesday, May 11th, 1881.

IRA S. KINCH, being recalled for cross-examination, deposes and says, in answer to interrogatories proposed by J. J. Storrow, Esq., counsel for Mr. Bell, as follows:

IRA S. KINCH. 1189

16 x-Q. Please look at your 15th answer and tell me what employees of what company you refer to?

A. I prefer not to do so, as I do not want to get anyone else into trouble.

Last clause of answer of witness objected to by counsel for Bell as improper and scandalous.

17 x-Q. When did you have this alleged conversation with these unnamed employees of an unnamed company?

A. About the middle of April, 1881. 1190

18 x-Q. Were you subpoenaed to testify in this matter?

A. No, sir.

19 x-Q. When were you first asked to testify in this matter?

A. About the first week in April, 1881; I can't give the date exactly?

20 x-Q. What was before you had the conversation just referred to?

A. Yes, sir.

21 x-Q. Who first asked you to testify in this case?

A. Mr. Hughes.

22 x-Q. Do you mean the gentleman who testified the same day you did?

A. His name is Charles T. Hughes. 1191

23 x-Q. What did he tell you he wanted to prove by your testimony?

A. The advantages of the Edison transmitter over the Blake, as far as my experience went.

24 x-Q. Was it at his suggestion that you had this conversation with this unnamed person?

A. No, sir.

1192 CHARLES T. HUGHES.

25 x-Q. Was it in consequence of what passed between you that you had this alleged conversation?

A. No, sir.

30 x-Q. When did you first tell Mr. Hughes that you had this alleged conversation?

A. I did not tell Mr. Hughes anything about it.

27 x-Q. When did you first tell anybody about it?

A. At the time I answered the question—April 27th.

28 x-Q. Do you mean to say that you never said to anybody that you had had such a conversation

1192 until the fifth question was read to you by the examining magistrate, Mr. Pinckney?

A. Yes, sir.

IRA S. KINCL.

OFFICE OF L. W. SERRILL,
140 Nassau Street, New York, N. Y.,
Thursday, April 28, 1881.

CHARLES T. HUGHES, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrill, Esq., counsel for Mr. Edison, as follows:

1 Q. Please state your name, age, residence and occupation?

1194 A. Charles T. Hughes, 34 years of age; residence, New York, N. Y.; occupation, purchasing agent for T. A. Edison.

2 Q. Have you made any experiments to test whether or not the instruments, Edison's Exhibits A and A', are capable of practical operation, and if so, what did you do?

A. On the night of March 25th, 1881, with Martin Force I tested the instruments, Edison's Ex. A and A', and found them efficient both as transmitters and receivers. I placed them on a metallic circuit

Ex A & A'
used,

CHARLES T. HUGHES. 1155

with a battery between, and talked into one with Force listening to the other, and then listened while Force talked from the other end. This took place in the laboratory at Menlo Park, from the extreme front end up stairs, to the extreme rear end down stairs in the chemical laboratory, with two doors closed between. We could hear talking quite plainly, also, called Francis Jehl, who both talked and listened. I heard him, and he me. I tried the instrument, exhibit A' as a receiver in connection with a carbon transmitter and got talking perfectly

3 Q. Have you ascertained whether or not the Edison Carbon telephone, corresponding to "Wiley's exhibit, Edison's Carbon Telephone No. 16," or "Prescott's exhibits, Edison's Carbon Transmitters No. 8 and 10, are capable of use at the present time? and if so, state what was done?

A. I have, on April 26, 1881, with Martin Force, I tested three telephones corresponding to these exhibits, between the laboratory and the office at Menlo Park, without induction coils, and with a magneto receiver, and found them to be efficient working instruments.

4 Q. Please state what character of carbon was made use of in these instruments?

A. I have the instruments here present, and in the two Nos. 13 and 80, silk buff, with plumbago rubbed into it, and in instrument No. 92 was placed, washers of silk cloth rubbed with plumbago. 1197 If there was any difference in them it was hardly noticeable. They worked satisfactorily as transmitters. These instruments were found in a box containing 50 or more similar instruments, in the attic of the laboratory at Menlo Park. They have not been disturbed since I went there in 1879, and I don't know for how long before that time. They correspond very nearly to the Wiley exhibit, Edison Carbon Telephone No. 10.

Carbon piston
works also
tested

1108 CHARLES T. HUGHES.

Instruments offered in evidence, marked "Hughes' exhibits, Edison's Carbon Telephone 13-80 and 92."

Counsel for Voolker and Irwin objects as not proper to put in rebutting testimony.

5 Q. Have you at any time been connected with any telephone company or exchange, if so, where?

A. In October, 1879, I was connected with the Commercial Telephone Company of Albany, New York.

1109 6 Q. What instruments were made use of as transmitters by that company?

A. The Edison Carbon Transmitter, the same as the instrument marked "Exhibit Edison Carbon Telephone" in this case.

7 Q. To what extent were those Edison Carbon Telephones employed, and how satisfactorily?

A. In October, 1879, there were more than 600 of them in use in our two exchanges, and all of them gave the best of satisfaction.

8 Q. Do you know whether the Bell magneto instruments were in use at Albany, and if so, to what extent and how satisfactorily?

A. I know that they were in use, and that there was a great deal of complaint about them. It was hard to get service with Central station. The talking was low when they did get service.

1200 9 Q. Do you know Mr. Gardner Earl?

A. I do.

10 Q. State what his business is?

A. President of the Troy Telephone Company?

11 Q. Have you at any time recently seen him with reference to giving testimony in this case; if so, when and what passed?

A. I have in the Startevant House, as late as Tuesday, April 26, 1881. I asked him for information regarding the working of his exchange, the in-

DAVID W. ODIORNE. 1201

struments in use, and if he experienced any difficulty in getting the instruments he wanted to, and he replied that the instrument in use was the Edison carbon transmitter, and it gave entire satisfaction, although when he had given orders lately for them, if filled at all, it was after great delay and by telephones, which had been repaired, and not new ones; he also informed me that there were no Edison Carbon Transmitters being manufactured. I asked him if he would come here and testify to points upon which we conversed, and he said that he would, but was called away before being able to do so.

1202 Objected to by counsel for Bell as incompetent and as purporting to give secondary evidence of an ignorant person's conjectures.

CHAS. T. HU. RES.

OFFICE OF L. W. SERRELL,

140 Nassau Street,

New York, N. Y.,

Thursday, April 28, 1881.

David W. Odiorne, being duly sworn, deposes and says, in answer to interrogatories proposed by L. W. Serrell, Esq., as follows:

1 Q. Please state name, age, residence and occupation?

A. David W. Odiorne, 30 years of age, residence Elizabeth, N. J., place of business, 110 Walker street, New York, N. Y.; I am a manufacturer of umbrella cases and trimmings.

2 Q. Have you ever made use of telephones in your business; if so, to what extent, and during what time?

A. I have; I first used them in 1878, and have used them ever since; I have a small central office and have the umbrella frame generally connected with my office; I now have (17) seventeen instruments in use—fifteen connected with my office here and two at my residence.

3 Q. Whose transmitting instruments have you used?

A. I have used both the Edison and Blake transmitters.

4 Q. When did you first commence the use of the Edison transmitter?

1205 A. In March, 1879; it was what was known then as the Edison No. 34 style; it was similar to the instrument marked Ex. Edison Carbon Telephone, with the exception that it had a casting that you screwed down to the box. This was simply to support it in place. The construction I should judge was just the same as this exhibit. I had 14 of these instruments. These instruments were changed about January or February, 1880, for what is known as the Edison Universal, which is provided with a desk and adjustable arm, the transmitting telephone being identically the same as the Exhibit, Edison Carbon Telephone.

5 Q. Have you any preference for either of the transmitters you have used; and if so, what is the reason or ground of your preference?

1206 A. I have a decided preference for the Edison, because when once set and adjusted it is always the same, regardless of the tone of voice with which it is used, or the strength of the battery. Most of the Edison instruments which I had put in in January or February, 1880, have never been adjusted since, and are working just as well as the day they were put up; furthermore, in speaking on long distances, they are the only instruments, I think, they are the most successful for overcoming inductions.

6 Q. What difficulty, if any, have you experienced with the so-called Blake Transmitter?

A. In ordinary use, if speaking too loud, it would break; thereby making the voice unintelligible, and has to be adjusted according to the strength of the battery.

7 Q. What range of battery can you use with the Edison and the Blake instrument, respectively?

A. With the Edison I have used from one cell of a Leclanche battery to 13 cells of gravity, and found it made no difference and required no adjusting. With the Blake I have never tried over two cells of battery, and even then it had to be adjusted very tight to use.

8 Q. Over what length of lines have you used the Edison transmitter?

A. I frequently use it from New York to Elizabeth, a distance of about 15 miles, the way the wire runs, and have used it from Elizabeth to Trenton. I have used the Blake instrument in the same manner.

9 Q. Do you know whether or not efforts are being made by the Bell Company to direct attention to, and to introduce the Edison carbon transmitter in telephone business in this city?

A. I do not think they are.

10 Q. Have you heard of any instance where the Edison carbon telephone has been introduced into the telephone business in this city during the past 1207 year or year and a half by the Bell Co.?

A. I have not.

11 Q. Does your business frequently bring you into contact with parties using and managing telephones in this city?

A. My business brings me in contact only with the officers of the Metropolitan Telephone Company, which represents the Bell Company in this city and 33 miles around.

1210 DAVID W. ODORNE.

19 Q In these tests of the Edison and so-called Blake instruments over long lines, as spoken about, did you discover any difference in the operations of the two instruments?

A In using the Blake transmitter between New York and Elizabeth, I could only use it under the most favorable circumstances; if there were any induction of any kind I could not use it. The Edison instrument overcomes the induction to a great extent. The articulation in the Edison instrument was always good, no matter how loud you hallooed into it. In the trial between Elizabeth and Trenton, I could not use the Blake at all.

1211 19 Q Do you discover any difficulties arising in the Edison instrument in connection with the tone of voice?

A None whatever. I myself would not use any instrument but the Edison as long as I can get them. With the Edison instrument you can either talk low or loud. My subscribers have the privilege of talking over the Metropolitan District through my office, and in many cases daily I find they have trouble in distinguishing what is said by the parties they call for on the Blake transmitter, which arises from the parties who use them not talking in the same tone of voice, or in the tone that the instrument is adjusted for. Parties in the Metropolitan circuit have no trouble in hearing my subscribers, who all use the Edison instrument.

1212 We have no trouble in communicating with subscribers in the Metropolitan District, we using the Edison transmitter, if there is no trouble with the line itself.

D. W. ODORNE.

DAVID W. ODORNE. 1213

OFFICE OF L. W. SEERELL,
140 Nassau street, New York, N. Y.,
Wednesday, May 11, 1881.

DAVID W. ODORNE, being recalled for cross-examination, deposes and says: In answer to cross-interrogatories proposed by J. J. STURROV, Esq., counsel for Bell, as follows:

14 x-Q I call your attention to your ninth and tenth answers, and ask you whether you undertake to swear that the Metropolitan Company does not put out for the use of its customers, Edison's soft carbon instruments?

A I do not swear that they do not put out such as they have in use, but I do not think that they put out any new instruments in their district. 1214

15 x-Q You mean by that, I suppose, that you think they do not put out any new Edison soft carbon instruments for the use of new customers?

A Yes.

16 x-Q Is it not the fact that they constantly keep a stock of Edison instruments on hand, and furnish them to every customer who prefers them, and allow every customer to take his choice between that and the Blake?

A They always have on hand some of the Edison instruments that, come into their possession from the Gold and Stock Company on consolidation, and such as demand the Edison instrument they supply them with some of them. 1215

17 x-Q Have you any personal knowledge of the number of Edison instruments the Metropolitan Company have introduced to new customers the past year, and if so, state exactly what your knowledge is on the subject?

A I have not.

18 x-Q When you were arranging for the removal your contract with the Metropolitan Company this year, did you not first ask for the Blake transmit-

1210 DAVID W. ODIORNE.

ter for your own exchange, and then, as an alternative, express your willingness to retain and take Edison's?

A. I made a much lower proposition to them for telephones, in which I think I stated that I would take the Blake transmitter and Bell receiver and mount myself, or would retain the present instruments that I had.

Redirect: By L. W. Serrell, Esq., Counsel for Mr. Edison.

19 R. D. Q. In the proposition to the Metropolitan Co. was anything said about the Edison instrument, or any preference for that over the Blake instrument?

1217 A. There was not.
20 R. D. Q. Did you, in your proposition, make any provision for the removal of the Edison instruments? and why did you make the proposition to take the Blake instruments?

A. There was no provision made for the removal of the Edison instruments; my only reason, in the proposition to use the Blake instrument, was to reduce my rental one-third, and I anticipated that, if they accepted my proposition, they would prefer having the old Edison that I had in use to putting in new Blake instruments; I was under the impression that the Edison instruments might cost the Metropolitan Company more royalty, and I might, perhaps, get the Blake on the terms of my proposition, which would answer my district, as described as being within a radius of one half mile.

Recross: By J. J. Storow Esq.

21 R. x-Q. Do you seriously mean to swear that the Edison instruments cost the Metropolitan Co. more royalty than the Blake?

A. I do not; in my last answer I meant to say, 1910 if I did not, that I was under that impression; I do not know what royalty they pay for either.

D. W. ODIORNE.

STATE OF NEW YORK, } ss.
County of New York.

I, George T. Pinckney, a notary public within and for the County of Kings, certificates filed in New York County, and State of New York, do hereby certify that the foregoing depositions of Edward H. Johnson, Ira S. Kinch, David W. Odiorne, and Charles T. Hughes, were taken on behalf of Thomas A. Edison on rebuttal, in pursuance of the notices hereto annexed, before me, at 140 Nassau street, in the City of New York, in said county, on the 27th, 28th and 29th days of April, 1881.

That each of said witnesses were by me duly sworn before the commencement of his testimony; that the testimony of each of said witnesses was written out by myself; that the opposing parties E. Gray, A. G. Ball, G. B. Richmond, W. L. Voelckers, J. H. Irwin, and Francis Blake, Jr., were present by counsel (but that J. W. McDonough and A. E. Dolbeer did not attend, either personally or by counsel) during the taking of said testimony.

That said testimony was commenced at eleven o'clock A. M. on the 27th day of April, 1881, and was continued pursuant to adjournment, and concluded on the 29th day of April, 1881; that I am not connected by blood or marriage with either of said parties, nor interested, directly or indirectly, in the matter in controversy.

In testimony whereof I have hereunto set my hand and affixed my seal of office, at New York City, in said county, this 30th day of April, A. D. 1881.

GEO. T. PINCKNEY,
Notary Public.

[SEAL.]

1220

1221

THE
SPEAKING TELEPHONE
INTERFERENCES.

Edison,
Bell, Gray,
and Others.

Cases A. to L.
and
No. 1.

EVIDENCE FOR THOMAS A. EDISON.

VOL. 2.

INTERFERING APPLICATIONS AND EXHIBITS.

FRANK W. SHERBELL,

FOR EDISON.

EDISON'S RECORD.

Vol. 2.

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DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

TO ALL PERSONS TO WHOM THESE PRESENTS SHALL COME, GREETING:

This to certify that the annexed is a true copy from the files of this office of the file wrapper and contents, in the matter of the application of Thomas A. Edison, ss/or to Western Union Telegraph Company, filed April 27, 1877, for speaking telegraphs.

In testimony whereof, I, W. H. Doolittle, acting commissioner of patents, have caused the seal of the Patent Office [SEAL] to be hereunto affixed this twenty-ninth day of December, in the year of our Lord one thousand eight hundred and seventy-nine, and of the independence of the United States the one hundred and fourth.

W. H. DOOLITTLE,
Acting Commissioner.

TO THE HONORABLE COMMISSIONER OF PATENTS:

Your petitioner, Thomas A. Edison, of Menlo Park, in the county of Middlesex, and State of New Jersey, prays that letters patent may be granted to the Western Union Telegraph Company of the city and State of New York, as his assignee for the invention of an improvement in speaking telegraphs (case No. 130), set forth in the annexed specification.

And further prays that you will recognize Lemuel W. Serrell, of the city of New York, N. Y., as his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

TTHOS. A. EDISON.

NEW YORK, N. Y., April 18, 1877.

UNITED STATES OF AMERICA.

CITY, COUNTY AND
STATE OF NEW YORK, ss.

On this eighteenth day of April, in the year one thousand eight hundred and seventy-seven, before the subscriber, a notary public

EDISON'S CASE "130."

in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within described improvement in speaking telegraphs, and that he does not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States, and a resident of Menlo Park, N. J.

THOS. A. EDISON.

Sworn to before me the day and year above written,

[L. s.]

Geo. T. PUCKNEY,
Notary Public,
Kings Co.

TO ALL WHOM IT MAY CONCERN.

1. Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex, and state of New Jersey, have invented an improvement in Speaking Telegraphs, of which the following is a specification.

2. Telegraphs have been made to operate by sound, and the movement of a diaphragm has been employed to open and close an electric circuit. In cases where reeds or bodies following the law of the pendulum have been made use of, the same respond to changes of tone, and produce musical sounds. In telegraphs that are intended for transmitting spoken words, there is a difficulty arising from those words generally being uttered in one key or tone or nearly so, and hence they are not distinct and clear.

Erased and
inserted June
21, 1879.

3. This present invention I designate as a *phonetic* or *speaking* telegraph, because it is adapted to transmit spoken words regardless of the musical key.

4. In the drawing Fig. 1, is a section of the transmitting instrument, and Fig. 2, is a similar view of the receiving instrument, the wire connections between the two serving to illustrate the telegraph line and electric circuits.

5. The resonators, or sounding tubes or boxes A B, are of any desired size shape or material; the box A, is the one into which the

¹ Tele-specimen. — The word "phonetic" has been erased, and "tele-specimen" substituted. See letter of June 21, 1879, p. 2.

FILE-WRAPPER AND CONTENTS.

words are uttered, and the box B or resonator is the responding part to which the attendant listens.

6. The diaphragms *c d*, are applied at the side or end of the respective boxes, and these should be provided with clamping rings *e f*, and tightening screws *g*, somewhat on the plan of a kettle drum, so that the diaphragms may be of the proper tension. I prefer and generally use sheet metal for these diaphragms, which may be of a suitable thickness, say one eighth of an inch more or less according to the size of the instrument.

7. In front of the diaphragm *c*, of the transmitter I make use of a second plate, or a disk *n*, of suitable material having a conducting surface.

8. I have found that a disk of hard rubber coated with plumbago, answers well, but a disk of some conducting metal or substance may be employed, or a plate of metal coated with some semi-conducting substance may be used.

9. The circuit wires 3, and 4, from the line and a battery or other source of electricity are connected to this apparatus, either at opposite sides of the disk *n*, or one wire may be connected to said disk *n*, and the other to the diaphragm *c*.

10. At the receiving instrument there is an electro-magnet *o*, with its poles facing the diaphragm *d*, and the armature *r*, is fastened to said diaphragm, or the diaphragm itself may form the armature if made of soft iron.

11. The disk or plate is accurately adjusted to the proper proximity to the surface of the diaphragm so that in a state of rest there will be little or no current passing from the battery upon the line, but the vibrations that are received by the diaphragm *c*, from the voice cause the electric energy on the line to increase and decrease according to the intimacy of contact between the vibrating diaphragm and the surface of the adjacent disk, for if the electric conductors are connected to the diaphragm and disk respectively, the current that passes will be pulsed and raised or lowered by the intimacy of contact of the surfaces or by the variable resistance where the conductors are in contact with a surface of plumbago, or other poor conductors of electricity, the current being increased by the diaphragm affording less resistance than the plumbago, when the

EDISON'S CASE "130."

vibration of the diaphragm brings the surfaces into contact to a greater or less extent.*

12. By this phonetic or speaking telegraph the diaphragm at the receiving station will be influenced by the action of the electro-magnet in the same proportion as the rise and fall of electric energy produced by the vibrations of the voice, regardless of the musical key, and the utterances at one end are reproduced at the other with great clearness and accuracy.

13. The electro-magnet, or helix *f*, introduced in the branch 10, between the main line and the earth is adjusted by a rheostat or otherwise to neutralize the static charge and discharge in the line [for by responding to the rise and fall of tension its action is the reverse of the static charges and discharges of the line] as heretofore employed by me in chemical and other telegraphs, and hence any false vibration from the effect of static charge or discharge are prevented. "A."*

1st claim as my invention

* "D" here inserted is as follows:—

"In all instances the diaphragm coming into contact with the disk, to a greater or less extent according to the amplitude of its vibration, leaves or increases the distance that the electric current is obliged to travel over the surface of the disk of phosphorus or similar insulating material, and consequently the resistance in the line and rise and fall of electric tension." See letter of Oct. 30, p. 12.

* "A" here inserted is as follows:—

"The static resistance to a pulsation is lessened by the action of the electro-magnet helix, because in practice the electro magnet in the circuit aids the pulsation so that it becomes more distinct at the receiving station, and when the pulsation ceases upon the line there is a static discharge that is met and neutralized pulsation. This is of great importance in speaking telegraphs in making the sounds clear and distinct instead of the tones running into each other."

See letter of June 21, 1877, p. 5.

* "E" inserted before the claim is as follows:—

"I do not herein make any claim to the iron or steel diaphragm combined with the electro-magnet and resonant cases, but reserve the same for a subsequent separate application."

See letter of Feb. 14, 1878, p. 2.

Subsequently there was also inserted before the claims the following paragraph:—

"I am aware that in kettle drums and basins the diaphragm is provided with screws for tightening the same. I do not claim in my present instrument the combination with the diaphragm of a ring or frame and screws for adjusting the parts."

See letter of Oct. 15, 1877, p. 11, "C."

4

FILE-WRAPPER AND CONTENTS.

First. A telepeena* consisting of a receiving diaphragm operated by an electro-magnet, and a transmitting disk or plate, and a diaphragm that is vibrated by the voice and produces rise and fall of electric tension on the line in proportion to the extent of motion of the diaphragm, substantially as set forth.

[*Second.* The combination with the main line and the telepeena transmitting and receiving instrument, of an electro magnet or coil in a branch or shunt circuit, substantially as set forth.]

Second. A diaphragm and its supporting case or box adapted to being vibrated by the voice, in combination with a disk or contact plate and electric circuit, substantially as set forth.

Signed by me this eighteenth day of April, A. D. 1877.

TIOS. A. EDISON.

Witnesses:

GEO. T. PIERCEY,
HAROLD SERRELL.

NEW YORK, Feb. 14, 1878.

HONORABLE COMMISSIONER OF PATENTS:

Sir,—In the matter of my application for a patent on Speaking Telegraphs, case 130, filed April 27, 1877, I hereby insert the following before the claims.

[I do not herein make any claim to the iron or steel diaphragm combined with the electro-magnet and resonant case, but reserve the same for a subsequent separate application.]

TIOS. A. EDISON,
per L. W. SERRELL, Attorney.

* Speaking telegraph. The word "telepeena" has been stricken out and the words "speaking telegraph" written over it in red ink. See letter of June 21, 1877, p. 8.

The second claim as above in brackets was stricken out, and for it was substituted "B," a claim which was itself afterwards stricken out, but which read as follows:—

"*Second.* The combination in a speaking telegraph of the main line, and the transmitting and receiving instruments, and an electro magnet or coil in a branch or shunt circuit, substantially as and for the purposes set forth."

See letter of June 21, 1877, p. 5.

* "Third" has been stricken out, and "second" substituted in the margin. The original second claim was stricken out "without prejudice in case of future reissue." See letter of Sept. 21, 1877, p. 11.

EDISON'S CASE "150."

Room No. 118.

[No. 14]

[INTERFERENCE.]

INTERFERENCE A.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., March 26, 1878.

Also copy to
THOS. A. EDISON,
Care L. W. SENEZEL,
Box 4,689, NEW YORK CITY.
N. Y. City.

Please find below a copy of a communication from the Examiner concerning your application for patent for speaking telegraph (Case 150) filed Apr. 27, 1877.

Very respectfully,
ELLIS SPEAR,
Commissioner of Patents.

Your case above referred to is adjudged to interfere with the applications and patents named below, and the question of priority will be determined in conformity with the rules accompanying this. The preliminary statement demanded by Rule 53, must be sealed up and filed on or before the sixth day of May, 1878, with the subject of the invention and name of party filing it, inclosed on the envelope. The subject matter involved in the interference is,—
"The heretofore described art of transmitting and reproducing at a distance, sonorous waves or vibrations of any description which consists in increasing and decreasing the strength of an electric current traversing a circuit in such a manner as to produce in said circuit a series of electrical waves or vibrations precisely corresponding in their intervals of succession and relative amplitudes to the sonorous waves which are to be reproduced at the receiving station or stations, so that oral conversations, or sounds of any first chain.)
This is substantially the method specified in Bell's 5th claim, and is described in the applications of Edison, Berliner, Richmond, Dolbear and Holcombe.

FILE-WRAPPER AND CONTENTS.

PARTIES TO INTERFERENCE.

Elisha Gray, app'n filed Oct. 29, 1877 (No. 1.) attorneys of record, Baldwin, Hopkins and Peyton, Washington, D. C.
Emile Berliner, app'n filed June 4, 1877. Attorney of record, James L. Norris, Washington, D. C.
George H. Richmond, app'n filed Aug. 24, 1877. Attorney of record, George W. Dyer, Washington, D. C.
A. E. Dolbear, app'n filed Oct. 31, 1877 (A.) Attorneys of record, Frank L. Pope, Elizabeth, N. J., James L. Norris (Asso. Atty), Washington, D. C.
A. G. Holcombe, app'n filed Jan. 28, 1878. Attorney of record, Moses G. Farmer, Torpedo Station, Newport, R. I.
A. G. Bell, Patent No. 174,465 dated March 7, 1876. Attorney of record, A. Pollok, Washington, D. C.

H. C. TOWNSEND,
Examiner.

Room No. 118.

[No. 14]

[INTERFERENCE.]

INTERFERENCE B. (Case 150.)

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., March 26, 1878.

Also copy to
T. A. EDISON,
Care L. W. SENEZEL,
Box 4689, N. Y. City.
N. Y. City.

Please find below a copy of a communication from the examiner, concerning your application filed April 27, 1877. Speaking telegraph.

Very respectfully,
ELLIS SPEAR,
Commissioner of Patents.

Your case above referred to is adjudged to interfere with the applications and patent named below, and the question of priority

EDISON'S CASE "150."

will be determined in conformity with the rules accompanying this. The preliminary statement demanded by Rule 53 must be sealed up and filed on or before the sixth day of May, 1878, with the subject of the invention and name of party filing it indorsed on the envelope. The subject matter involved in the interference is the hereinbefore described improvement in the art of transmitting vocal sounds or spoken words telegraphically, which consists in throwing upon the line through the medium of a varying resistance electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air produced by a spoken word. (Gray's second claim.)

This is substantially covered in Bell's fourth claim, and is described in applications of Gray, Berliner and Richmond.

The parties to interference are Eliska Gray, application filed Oct. 21, 1877. Attorneys, Baldwin, Hopkins and Peyton, Washington, D. C. T. A. Edison, application filed April 27, 1877 (Case 130). Attorney, L. W. Serrell, Box 4689, New York City. Emile Berliner application filed June 4, 1877. Attorney, James L. Norris, Washington, D. C. George H. Richmond, application filed Aug. 24, 1877. Attorney, George W. Dyer, Washington, D. C. A. G. Bell, Patent No. 174,465, dated March 7, 1876. Attorney, A. Pollak, Washington, D. C.

H. C. TOWNSEND,
Examiner.

New York, April 26, 1877.

HON. COMMISSIONER OF PATENTS:
Sir,—I inclose check for \$45, fees on the applications for patents, sent herewith of:—

Thomas A. Edison, speaking telegraphs,	\$15
Owen Tumlison, car axle boxes (reissue),	30
	\$45

Respectfully yours,
LEMUEL W. SERRELL,
per C. H. SMITH.

FILE-WRAPPER AND CONTENTS.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

Room No. 118.

WASHINGTON, D. C., June 20, 1877.

THOS. A. EDISON,
Care L. W. SERRELL,
Box 4689, New York City.

Case 130.

SPEAKING TELEGRAPH, FILED APRIL 27, 1877.

This application has been examined. The second claim appears to cover a mere double use of an electro-magnet or coil, as ordinarily employed in telegraphs, and as shown for example, in patents of J. B. Sisson, Mar. 18, 1873, No. 136,873 (Duc. Duplex Telegraphs), and T. A. Edison, Feb. 10, 1874, No. 147,313 (Automatic Telegraphs). The meaning of the statement in paragraph thirteen of specification, that the action of the coil is the reverse of the static charges and discharges of the line as heretofore employed by me in chemical and other telegraphs, is not clear.

The signification of the word "telespecan" employed in claims 1 and 2 is not understood and the propriety of using it cannot be seen.

As presented the application is rejected.

H. C. TOWNSEND, *Ex'r.*

New York, June 21, 1877.

TO HONORABLE COMMISSIONER OF PATENTS:

Sir,—In the matter of my application for Letters Patent on Improvement in Speaking Telegraphs (case No. 130), filed April 27, 1877, I amend the specification by erasing the word "phonetic" in second line of paragraph 3, and substituting the word "telespecan."

By erasing in the middle of paragraph 13, the words "for by responding to the rise and fall of tension, its action is the reverse of the static charges and discharges of the line."

By inserting the following at the end of paragraph 13,

EDISON'S CASE "130."

"A."

"[The static resistance to a pulsation is lessened by the action of the electro-magnet helix, because in practice the electro-magnet in the circuit aids the pulsation so that it becomes more distinct at the receiving station, and when the pulsation ceases upon the line there is a static discharge that is met and neutralized by the discharge of the electro-magnet, so that there is no prolongation of the pulsation." This is of great importance in speaking telegraphs in making the sounds clear and distinct instead of the tones running into each other.]

Insert "C"
Oct. 13, 1877.

By erasing the word "telegraph" in first line of claim 1st, and substituting the words "speaking telegraph,"?

By erasing the second claim and substituting the following:—

Erased per
ADJUT. GEN. ST.

"[Second. The combination in a speaking telegraph of the main line, and the transmitting and receiving instruments, and an electro-magnet or coil in a branch or shunt circuit, substantially as and for the purposes set forth.]"

Respectfully yours,

THOMAS A. EDISON,
per LEMUEL W. SCHRELL, *Atty.*

Room No. 118.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

Case 130.

WASHINGTON, D. C., Sept. 20, 1877.

THOMAS A. EDISON,

Care L. W. SCHRELL, N. Y. CITY.

SPEAKING TELEGRAPH, FILED APRIL 27, 1877.

This case as amended June 22, has been considered. It is still held that the second claim covers a mere double use of the well-known "magnetic shunt." The action of this shunt as described and shown in the present case is precisely the same as in those instances where it has been heretofore used, and the result is in this as in other cases, "distinctness of pulsations." The mere addition

* For "C" here inserted, see p. 4, and p. 12.
10

FILE-WRAPPER AND CONTENTS.

of this "shunt" to any system of telegraphy without any distinctively new result is held not to constitute invention.

The second claim is accordingly refused.

H. C. TOWNSEND,
Examiner.

NEW YORK, Sept. 21, 1877.

TO HON. COMMISSIONER OF PATENTS:

Sir,—In the matter of my speaking telegraph, case 130, filed April 27, 1877, I amend the specification by erasing the second claim without prejudice in case of future revision.

THOS. A. EDISON,
per L. W. SCHRELL, *Atty.*

Room No. 118.

DEPARTMENT OF THE INTERIOR.
UNITED STATES PATENT OFFICE.

Case 130.

WASHINGTON, D. C., Sept. 25, 1877.

THOS. A. EDISON,

Care L. W. SCHRELL, N. Y. CITY.

SPEAKING TELEGRAPH, FILED APRIL 27, 1877.

On the subject-matter of the combination of the frame, the diaphragm and the tightening screws, an interference between this and another pending application will be necessary.

This interference will be declared as soon as the conflicting application is put into proper condition.

H. C. TOWNSEND,
Examiner.

NEW YORK, Oct. 13, 1877.

TO HON. COMMISSIONER OF PATENTS:

Sir,—In the matter of my application for a patent on Speaking Telegraphs, Case 130, filed April 27, 1877, I amend the specification by inserting the following before the claim:—

EDISON'S CASE "130,"

"C." [I am aware that in kettle drums and banjos the diaphragm is provided with screws for tightening the same. I do not claim in my present instrument the combination with the diaphragm of a ring or frame and screws for adjusting the parts.]

THOMAS A. EDISON.

NEW YORK, Oct. 30, 1877.

To HON. COMMISSIONER OF PATENTS:

Sir, — In the matter of my application for a patent on Speaking Telegraphs, Case No. 130, filed April 27, 1877, I amend the specification by adding after paragraph 11, as follows:—

"D." [In all instances the diaphragm coming into contact with the disk, to a greater or less extent, according to the amplitude of its vibration loosens or increases the distance that the electric current is obliged to travel over the surface of the disk of plumbago or similar inferior conducting material, and consequently the resistance in the line and rise and fall of electric tension.]

THOMAS A. EDISON,

per L. W. SCHRELL, Attorney.

WASHINGTON, D. C.

187

In a speaking telegraph the transmitting diaphragm vibrates against a plate or disk, the rise and fall of tension being produced by the varying extent of contact.

No. 11

1877.

No. 130

THOMAS A. EDISON,

Agent to Western Union Telegraph Company of New York, N. Y.

Of Menlo Park, County of Middlesex, State of New Jersey.

SPEAKING TELEGRAPHS.

April 27, 1877.

Rec'd.
Petition
Affidavit
Specification
Drawing
Model

" " " " " "

12

FILE-WRAPPER AND CONTENTS.

Cert. dep.

1 Cash \$15.

Add'l Fee Cert.

" " Cash.

Examined.

Issue.

2 Patented

3 Circular.

April 27, 1877.

187

LEMUEL W. SCHRELL,
Box 4689, New York City.

1877.

CONTENTS.

Application

Papers.

1 Re-j June 20, 1877.

2 Am'd " A B " June 22, 77.

3 Re-j Sept. 20, 1877.

4 Am'd Sept. 27, 1877.

5 Re-j Letter Sept. 29, 1877.

6 Am'd Oct. 15, 1877 " C."

7 " " 31, " " D."

8 " Feb. 16, 1878 " E."

A. 9 Int'l $\times \frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, Mar. 26, 1878.

B. 10 Int'l $\times \frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, $\frac{1}{16}$, Mar. 26, 1878.

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36 Electricity.

Telephonic-Telegraphs

Title.
Improvement in

19

T. A. Edison,
Telephone.

APPLICATION No 100

Filed Apr. 27, 1877.

Fig. 1.

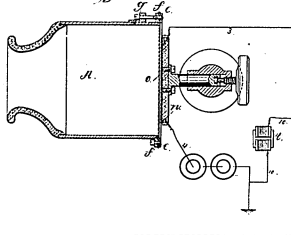
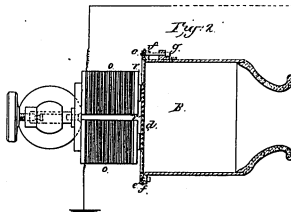


Fig. 2.



Witnesses:
Charles A. Smith
Geo. S. Buckley

Inventor:
Thomas A. Edison
per Samuel H. Ford
att'y

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY,

As to the Western Union Telegraph Company, of New York, N. Y.

PENDING APPLICATION FILED JULY 20, 1877. (No. 141.)

SPEAKING TELEPHONES.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex, and State of New Jersey, have invented an improvement in speaking telegraphs, of which the following is a specification:—

The object of this invention is to transmit the human voice over telegraphic wires for conversational purposes.

The invention consists in transmitting positive and negative currents of variable strength necessary to obtain the proper articulation, by means of double contact springs arranged on each side of a diaphragm, the extreme end of such springs being provided with points formed of semi-conductors such as plumbago, peroxide of lead, and other oxides and conducting material.

The invention further consists in the arrangement of the batteries with the double contact springs to insure the transmission of positive and negative currents.

The invention further consists in the receiving instrument for reproducing the vibrations from the transmitter.

Fig. 1 shows the transmitter and receiver. A is the resonant chamber over the end of which the diaphragm is stretched, either side of which may be made heavier in the centre by a small weight, if great amplitude is required of the diaphragm; *b*, *c*, are the two contact springs, having points made of compressed plumbago, mixed preferably with gum rubber, but any substance not liable to rapid decomposition may be used; these points face each other on the opposite side of the diaphragm, and make contact with platinum disks secured to the diaphragm; the spring *b* passes through a hole or small slot in the side of the transmitter. 2 and 3 are the main batteries; the battery 2 has zinc to the line or point *e*, and the battery 3 has copper to the line or spring *b*.

When the springs *c* and *h* are adjusted so as to make contact with the diaphragm equally, no current passes to the line, but when the diaphragm is vibrated, its movement to one side, say *c*, causes a greater pressure upon the plumbago on that spring, and a lessening of the pressure on the plumbago on *h*; hence the balance of the batteries 2 and 3 will be destroyed; 2 being given the advantage will send a negative current to line; upon the return of the diaphragm, the battery currents will again neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery 3 will send a positive current to the line. As plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak.

In Fig. 2 is shown the contact spring, which I prefer to use instead of *c* and *h*, which are used merely to assist in explaining the operations more clearly.

h is a U-shaped spring secured to the screw 8, which is adjusted back and forward by the thumb nut 9. 7 is the pillar holding such screws. *e* is a piece of soft rubber or equivalent substance placed between the prongs of the spring 5. 6 is a wire or band which serves to bind the prongs tightly against the rubber *e* so as to prevent the prongs acting as a tuning fork, and transmitting harmonic vibrations not desirable. 10 is the plumbago contact point. The object of the 1st spring and rubber is to present a semi-rigid point for contact so as to prevent a rebound, and allow of a slight yield when the diaphragm is pressed by the diaphragm. D is the receiver, which tube as in Fig. 3, or as a box as at D, Fig. 1; *f* is a rigid arm, adjusting screw *h*.

Near the end of the arm is secured a spring *g*, whose end rests upon the electrically prepared paper upon the drum *e*; the under side and decrease the pressure of the platin spring upon the paper.

When the paper is moved slowly by rotating the drum *e*, the waves of electricity coming over the line pass through the arm *f* to the platinized springs *g*, thence through the paper to the earth. If a negative current passes in the opposite direction, nearly all friction

between the platin plate and the paper ceases and the resonant box or diaphragm regains its normal position.

When the positive current passes through the same channel the normal friction of the paper is augmented, and the electrical surface acting upon the platin serves to give a movement to the resonant box. Thus the mechanical force applied to move the chemical surface acts with the electric current to produce the vibration of the resonant chamber.

The principle of this method of obtaining motion by electro-chemical decomposition is described in my Letters Patent No. 158,787, granted Jan. 19, 1875.

To facilitate the discharge of electricity from the receiving apparatus it may be shunted with an electro-magnet.

Fig. 4 shows the device which may be employed to rotate the drum *e* in a noiseless manner, so as to prevent interference with the weak, hissing consonants which form a part of ordinary conversation.

p is a worm and *o* the wheel for revolving the roller *e*. *t* is a universal joint connecting to the shaft *a*, the object of the shaft being to carry the actuating handle to the right side of the machine and the paper-carrying devices to the left-hand side. *v* is a spring which serves to press the rubber wheel *u* against the under surface of the wheel *u*, which also may be covered with rubber. *w* is the handle by which to rotate the disk *e*, shaft *a*, worm *p*, and roller *e*.

The mouth of the speaking-tube may be closed, except a horizontal slot through which the vibrations of the voice pass to the diaphragm or tympan, the object of the slot being to increase the power of the hissing consonants; also that the point *b* may be dispensed with on very short lines.

I claim as my invention, —

First. In a telegraphic apparatus operated by sound, the combination with the diaphragm or tympan of two contact points in the electro-circuit adjacent to the opposite surfaces, substantially as set forth.

Second. The combination with a diaphragm in a telegraph operated by sound of two contact points at opposite sides of the diaphragm and opposing batteries connected in the electric circuits, substantially as set forth.

[Third. In a telegraphic apparatus operated by sound, one or more contact points of yielding material that produce a rise and fall of electric tension proportionate to the pressure exerted by the diaphragm, substantially as set forth.*]

[Third. In a telegraphic apparatus operated by sound, the combination with the diaphragm of one or more contact points of phosphors or similar inflexible conductor, in the electric circuit, whereby the rise and fall of the electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm, substantially as set forth.†]

[Fourth. In a telegraph apparatus operated by sound, a receiving instrument provided with a resonant surface in combination with a frictional surface, moved by power, and acting in connection with the electric current to vibrate such resonant receiver, and produce tones corresponding to those at the transmitting apparatus, substantially as set forth.

Signed by me this ninth day of July, A. D. 1877.

THOMAS A. EDISON.

Witnesses:

EDWARD T. FISCHER.

WILLIAM G. MOTT.

* Part in brackets struck out by amendment.
† Part in italics inserted by amendment.

T. A. EDISON

APPLICATION · N° 141.

FILED JULY 20 1877.

Fig. 1

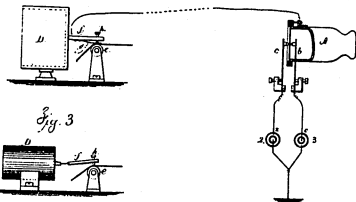


Fig. 3



Fig. 4

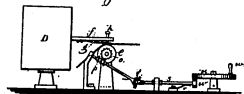


Fig. 2



Witnesses

Charles Smith
Edward Smith

Inventor

Thos. A. Edison.

J. Lemuel W. Smith

att'y.

[INTERFERENCES C AND D.]

THOMAS A. EDISON, OF MENLO PARK, N. J.

Answer to Western Union Telegraph Company, of New York, N. Y.

PENDING APPLICATION FILED SEPT. 5, 1877. IMP. IN TELEPHONIC TELEGRAPHY.

EDISON'S CASE NO. 144.

[Specification as amended and corrected.*]

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in Speaking Telegraphs, of which the following is a specification.

The object of this invention is to transmit and render audible the human voice over telegraphic circuits.

The invention consists in a tympan or diaphragm upon a speaking tube, connected with electrodes in an electrolytic fluid, so that the vibrations of the diaphragm cause the electrodes to approach and recede from each other, and vary the resistance in the electric circuit.

The invention further consists in the method of multiplying the effect of the approaching and receding of the electrodes by causing the current to pass through the electrolytic liquid at several places between the points which are vibrated by the tympan.¹

The invention further relates to the electrodes insulated except at their extreme ends.

The invention further consists in a case, containing an electromagnet with a loose plate at the end, which plate is placed against the ear when the speech is being received.

In the annexed drawing, *a* is the speaking tube, which may be made in any form; upon the lower end is secured a diaphragm *b*, of cork, mica, metal or other suitable substance, the diaphragm being

* Illustrated from specification originally filed by explanation in foot notes.

¹ In the specification originally filed there was here inserted the following paragraph:—

"The invention further consists in a perpendicular speaking tube and electrolytic cell and means for adjusting the cell containing the liquids to or from the tympan."

set in motion by the voice of person speaking in the upper part of the tube.

Secured to the diaphragm is a U-shaped piece of metal, d , insulated except at its extreme end; these ends dip into the cell B, containing the semi-conducting fluid.

Facing the ends, d , of the U-shaped electrodes are two other electrodes, f and g , which are also insulated, except on their extreme ends, where they face e and d .

The cell B is divided by an insulating diaphragm or partition, so that practically there are two electrolytic cells.

The cell is secured to an adjoining double-thread screw h , by which it may be adjusted up or down, hence the electrodes, e and d , f , can be made to approach very closely to each other.

I will now explain the action of the electric current.

When the diaphragm is in a state of rest and the electrodes are adjusted very close to each other, the current from the battery N , passes to the screw h , thence through it to the extreme point, thence through the fluid in B to the point d , through it to e , thence to its extreme point, thence through the fluid to the point g , to the earth. The resistance of the fluid between the points is considerable, causing the current to be weakened, and this effect is multiplied by the when polarizing solutions are used.

If now the diaphragm is vibrated, it causes the approach and recession of the points to and from each other, and this causes the current to traverse a greater or less amount of the fluid, thus throwing the electric current into waves, corresponding to the movement of the diaphragm; by using two electrodes, I nearly double the effect of a given movement of the diaphragm, for if but one electrode was used, a movement of the diaphragm of say one one-hundredth of an inch would shorten and lengthen the fluid conductor to that extent, whereas, with two electrodes, the length of the fluid conductor is doubled. In practice, I prefer to use several sets of electrodes in the circuit, so that the current must pass successively between the several pairs of electrodes (as in a galvanic battery connected together far intensify). Where a great number of points are used, the current is lessened by using a comparatively good conducting solution.

The plate r is of iron, preferably tinned; it is at the end of the

case t , within which case is the electro-magnet u , the helix of which is connected with the line circuit.

The waves thus sent over the circuit cause the electro-magnet u to attract the plate r at each vibration, and thus reproduce and render audible the voice of the person speaking into the tube a .

The advantage of using a loose plate over a plate secured at one end or around the edges, is that any free diaphragm setting the air in motion will give metallic ringing sounds or harmonics, due to its want of homogeneity, while with the loose plate held against the ear, these ringing sounds are dampened, and the sounds due both to the movement of the air, and the molecular sounds from the metal, due to the motion given by the magnet, are very loud, and are free from all secondary sounds which tend to destroy the perfect articulation.

By more or less pressure of the plate against the ear, it may be made to approach or recede from the magnet, thus increasing or decreasing the volume of the sound.

It is not necessary that the plate should be circular; it may be in any shape or of any material, providing it has secured to it an iron armature; this receiver is preferably connected to the line by a flexible cord containing two wires, and when placed in an inverted position so that the loose plate drops away from the magnet, the opening and closing of the circuit by a key will cause the plate to be attracted when the circuit is closed and fall away from the magnet by its own weight when the circuit is open, thus producing sufficient noise to act as a call in place of a bell. Of course, this receiver may be used in connection with any form of telegraphic transmitter.

I claim as my invention, —

First? In a telegraphic instrument operated by sound, the communication with the diaphragm of two or more electrodes placed in electrolytic liquid, and operating to increase and decrease the resist-

¹ The first claim originally read as follows:—

First. "The method herein described of increasing and decreasing the resistance of the electric circuit by causing two or more electrodes placed in electrolytic liquid to approach or recede from each other by a motion derived from the movement of a diaphragm actuated by the human voice or other sound for the purpose set forth."

ance of the electric circuit by the movement derived from the diaphragm, substantially as set forth.

Second. The combination with a diaphragm set in motion by the human voice or other sound, of several pairs of electrodes insulated, except at or near their end, and an intermediate fluid conductor for the purpose set forth.

Third. The receiving apparatus, consisting of an electro-magnet, case, and loose metal plate, arranged and operated substantially as set forth.

Fourth. The combination in a receiving instrument of an electro-magnet, a movable case and a loose plate, arranged substantially as set forth so that the same may be used either as a call or a receiving instrument.

Signed by me this thirty-first day of August, A. D. 1877.

THOMAS A. EDISON.

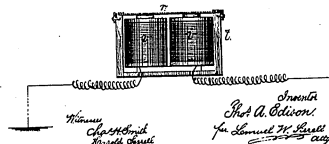
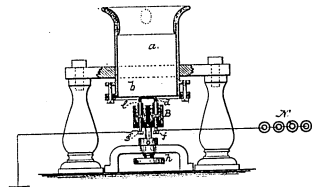
WITNESSES:

GEO T. PINCKNEY,
WILLIAM G. MOTT.

T. A. EDISON

APPLICATION M44

TILED Sept. 5. 1877.



Witness
Geo. T. Pinckney
William G. Mott

Subscribed
T. A. Edison
for Leonard W. Russell
at New York City

[INTERFERENCES R AND L.]

THOMAS A. EDISON, OF MENLO PARK, N. J.

Assignor to Western Union Telegraph Company, of New York, N. Y.
 PENDING APPLICATION FILED DEC. 13, 1877. 1878, IN TELEPHONIC TELEGRAPHS.

[EDISON'S CASE, NO. 163.]

[Specification as Amended and Corrected.*]

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an Improvement in Acoustic Telegraphs, of which the following is a specification.

My invention relates to an acoustic telegraph containing a plate capable of vibration to produce sound vibrations in the atmosphere, in combination with [a resonant tube], an electro-magnet and connections to a circuit over which undulatory electric waves are caused to pass by an acoustic telegraph transmitting instrument, so that sounds will be produced by said plate at the receiving instrument similar to those at the acoustic transmitting instrument. The same instrument is adapted to transmitting electric waves or pulsations corresponding to the sound vibrations of the atmosphere.

In the drawing—

Fig. 1 is a diagram illustrating the apparatus adapted to use in an acoustic telegraph in which there is a rise and fall of electric tension, and

Fig. 2 shows the apparatus adapted to a line in which the polarity of the current is reversed.

The resonant tube or case *a* is of a suitable size and shape, and *b* is the vibrating plate forming the whole or part of one side or end of the resonant tube or case.

This plate forms an armature to the electro-magnet *d*, said electro-magnet being connected with the distant instrument either directly or by an induction coil.

The plate *a*, is preferably polarized by the magnet *h*, which is shown as a permanent bar magnet, said plate *b*, being attached to one pole. The electro-magnet *d*, is also shown with shoes or branches to the cores with the armature plate *b*, between them.

In Fig. 1 the line *l*, is represented as passing through the helix

* Distinguished from specification originally filed by *fact-omnes*.

† The words "a resonant tube" were not in the original specification.

m , to the earth, and a is an induction coil around the same core as the helix m , and this helix a is in the local circuit passing through the helix of the magnet d .

If now the distant acoustic transmitting instrument produces a rise and fall of tension in the main line circuit l, m, c , then the current set up by polarization in the helix a will be alternately — and + and hence the pulsations of the cores of the electro-magnet d , will be constantly reversed and attract and repel the armature plate b , giving to the same vibrations corresponding in rapidity, suddenness and extent to those at the acoustic transmitting instrument, thus reproducing in the resonant tube s , the sounds that produced the corresponding vibrations and electric pulsations or waves at the transmitter.

If the acoustic transmitting instrument produces changes of polarity on the line, then the connections will be made as in Fig. 2, and the line current will pass directly through the helix of the electro-magnet d , but as acoustic instruments usually produce rise and fall of tension, it will generally be necessary to use the induction coil or magnet m, a , but it may be at the distant station as illustrated in Fig. 2, and the line current be pulsed thereby to act in the electro-magnet d .

If this instrument is used to receive the message, then the ear will be applied at the opening of the resonant tube s .

Several such instruments may be inserted in each wire and the length of the resonant tube made greater or less in length, whereby each particular tone is reinforced.

In this acoustic telegraph the armature plate has no musical tone, neither does it only respond to harmonic electric undulations, but it responds to all characters of electric waves or pulsations sent acoustically, so as to be influenced by the time of the electric waves, their intensity, suddenness or attenuation, and the circuit of the actuating electro magnet is continuous, so that the current therein will not be wholly interrupted.

I claim as my invention —

*First.*¹ The combination in an acoustic telegraph of an electro-

¹ This claim was originally the second. Preceding it in the application as filed, was the following: — "*First.* In an acoustic telegraph instrument an iron or steel plate polarized by a battery or by a permanent magnet forming also the armature

magnet, and a polarized armature formed of a plate of iron, steel or other material capable of inductive action, and a resonant tube or case, substantially as set forth.

*Second.*² The combination in an acoustic telegraph of an armature plate, polarized by induction [a resonant case or tube], and an electro-magnet and circuit connections substantially as set forth, whereby reverse currents are caused to act in the electro-magnet with varying intensity, proportionate to the electric waves sent from the transmitting station, substantially as set forth.

*Third.*³ In an acoustic telegraph an armature plate, the electro-magnet for the same, and a closed circuit passing from the helix of such electro-magnet to the source of undulatory electric energy, substantially as set forth.

Signed by me this eighth day of December, A. D. 1877.

THOS. A. EDISON.

WITNESSES:

GEO. T. PISCENEY.

CHAS. H. SMITH.

of an electro-magnet, and responding to the varying conditions of the electro-magnet resulting from the electric pulsations or waves from an acoustic transmitting instrument.

¹ This claim was originally the "*Third.*"

² The words, "a resonant case or tube" have been inserted by amendment.

³ The third claim was originally the "*Fourth.*"

T.A. EDISON
APPLICATION NO. 145.
FILED Dec. 13, 1877.

Fig. 1.

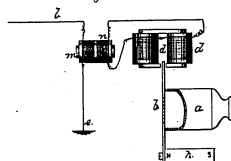
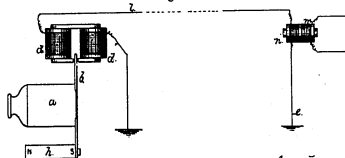


Fig. 2.



Witness
J. S. H. Smith
Per J. S. H. Smith

Inventor
Thomas A. Edison.
Per Edmund W. Russell
att.

[INTERFERENCES D AND J.]

THOMAS A. EDISON, OF MENLO PARK, N. J.

Assignor to Western Union Telegraph Company, of New York, N. Y.
PENDING APPLICATION FILED JULY 21, 1875. ACQUEDUCO TELEGRAPHS.

[EDISON'S CASE, NO. 145.]

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in acoustic telegraphs, of which the following is a specification:—

The object of this invention is to transmit several messages over one wire at the same time, by employing acoustic vibrations or waves passing over the line at different rates.

The invention relates especially to the apparatus for reproducing such waves at the distant station and separating each series so as to render them audible only in that instrument with which they are in unison.

In the annexed diagram, Fig. 1, the connections at one end are represented by a perspective view, and Fig. 2 is a section of the resonant tube.

F and G are the vibrating reeds, kept in continuous vibration by the electro-magnets R and S, in a local circuit provided with a suitable contact spring, operated by the reed in the usual manner, but which are not shown here for clearness.

M and N are electrolytic cells, arranged and operated similar to those shown in my patent No. 141,777; the armatures, however, of the electro-magnets are spring harmonic reeds instead of armatures with springs.

The vibration of one of the electrodes, serving to increase and decrease the resistance of the electric circuit by causing the electric current to pass through a greater or lesser amount of water between the electrodes.

L is the main battery in the main line T, the electrolytic cells N and M being included in the main circuit; H and K are keys used for the purpose of stopping and starting the waves over the wire, which they accomplish by short-circuiting the electrolytic cells N or M.

The reeds F and G are tuned to give different tones, and several reeds, substantially the same as herein described, may be included in the same circuit, all being toned differently.

A and B are the receivers, which are shown as resonant tubes.

Upon the ends of the resonant tubes are iron or steel diaphragms which act as the armatures of the electro-magnets E E', which are facing them.

X and X' are secondary tubes, which slide within the tubes A and B like the tubes of a telescope. The object of the tubes is to allow of the lengthening or shortening of the column of air in the resonant tube, so as to bring it in unison to the particular note or tone which it is desired to hear. The iron diaphragm responds to all the tones with equal power, and were not some means provided for strengthening or reinforcing one particular tone, it would be very difficult for the operator to pick out the tone required, but by the use of the resonant tubes this difficulty is overcome, because the tone is given distinct when the armature is vibrated in harmony with the note of the tube.

I claim as my invention:—

First. The combination with an electro-magnet of an iron or steel diaphragm, secured to a resonant case, for rendering audible acoustic vibrations, substantially as set forth.

Second. The combination with a diaphragm, vibrated by an electro-magnet, of a resonant tube, variable in its length, so as to adjust the column of air to the tone of the transmitting instrument, substantially as set forth.

Third. The combination with a vibrating reed and electrolytic cells placed in the electric circuit of a key, placed in a shunt circuit, substantially as set forth.

Signed by me this fifteenth day of December, A. D. 1877.

THOMAS A. EDISON.

Witnesses:

GEO. T. PIERCEY.

CHAS. H. SMITH.

T. A. EDISON
APPLICATION NO. 148.
FILED DEC. 24. 1877.

Fig. 1.

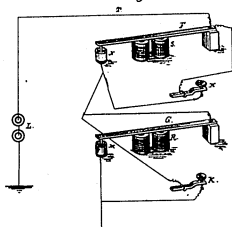
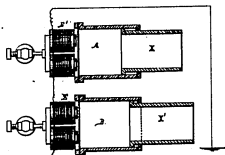


Fig. 2.

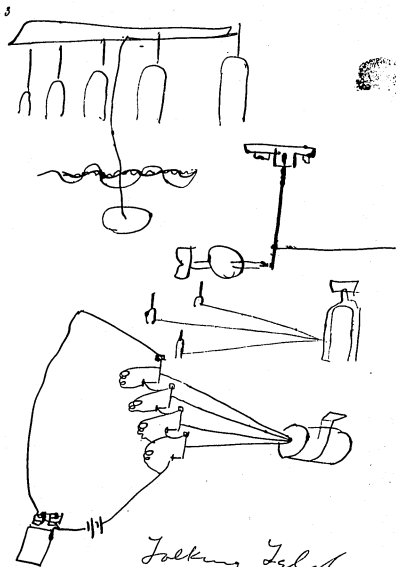


Witness
Charles Smith,
Sec. T. Edison

Inventor
Thomas A. Edison.
By Samuel H. Gould, atty.

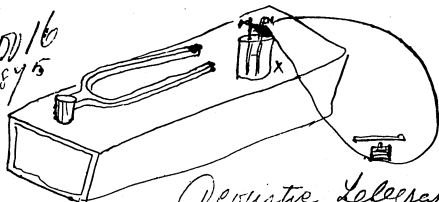
EDISON'S EXHIBIT.

Talking Telegraph July 12, 1876.



Talking Telegraph
July 12, 1876
Edison

Nov 16
1875

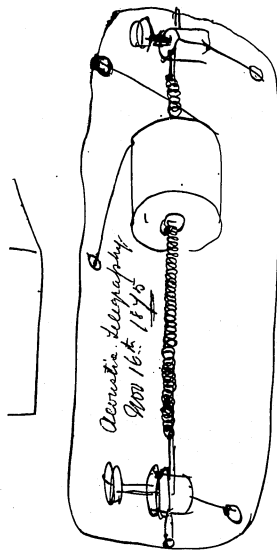


Acoustic Telegraphy

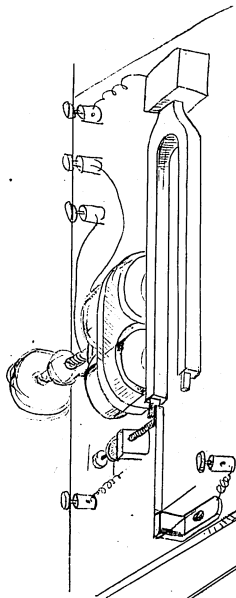
X is a quickly polarizing battery which depolarizes powerfully with the least jar, as the tuning fork responds only to vibration in unison with its swinging time. it will be seen that this in its turn will set the Resonant box vibrating depolarizing or knocking loose the hydrogen bubbles on the plates of the battery X increasing the strength & clearing the sound. The sound having low resistance a

J. A. Edison
Jas. Baird

John H. Kiser

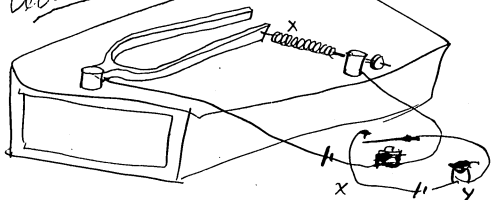


Iron wire duplicate • Charles B. Davenport
 Editor 7-9 S. L. G. J. A. Adams
 John D. Brown



Nov 16 1875 Chas Batchelor.
~~Patented~~ Acoustic Telegraphy
James Adams
Exhib 8-9, 1875

Nov 16 1875
Acoustic Telegraphy



X german silver ~~coil~~ in circuit with
galvanic battery & $\frac{1}{2}$ ohm sounder
when fork not vibrating. each
turn of the spring touches its neighbor
and the sounder X is closed
& Y is open - when fork
vibrates it sets the spiral
in motion & separates each coil
from a layer or another,
thus X & Y

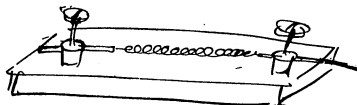
Edison Patent

J. A. Edison
for Adams

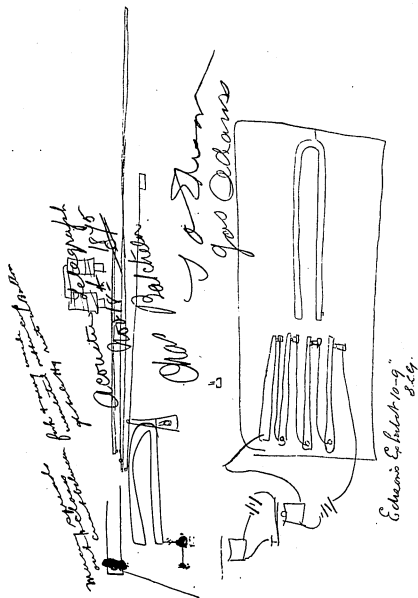
Edison Exhibit 9-9 Sec 9.

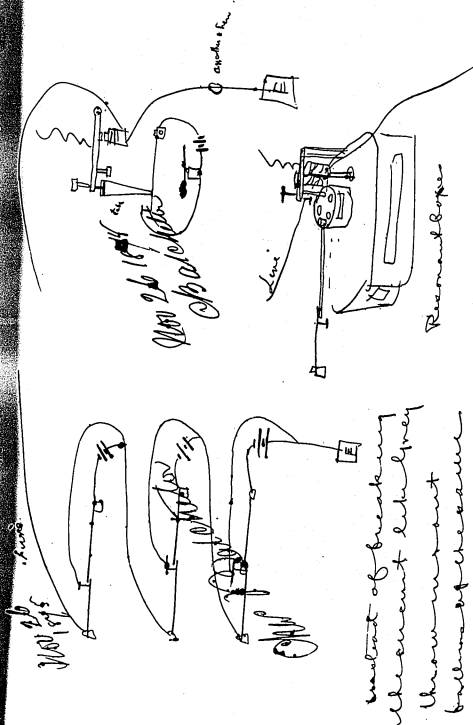
John H. Kuerst

Acoustic Telegraphy
Nov 16 1875



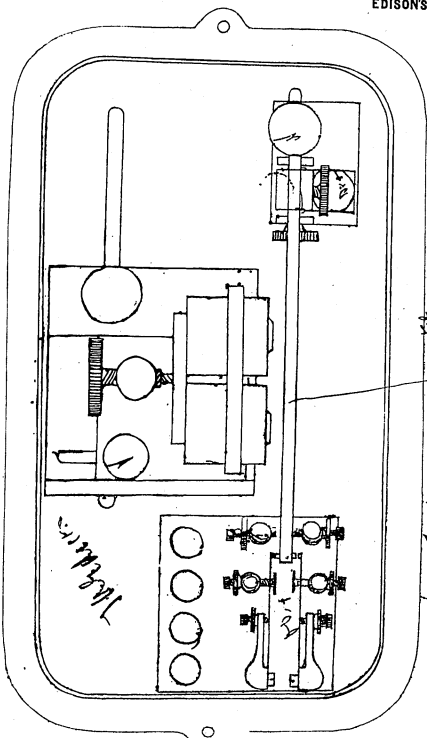
Edison
Chas. Batchelor
Gas Claims
John F. Russell



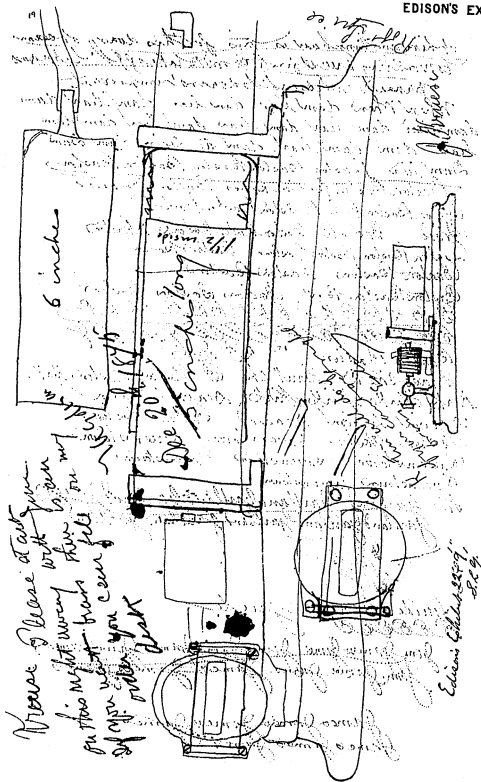


instead of breaking
the current like they
throw in a
battery of the same
size and pressure the
continuity =

Desires Engraving Nov 21st 1875

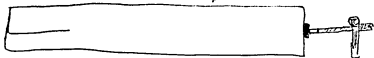


2 of these to be
Cheer Batcher
Lund 22-9

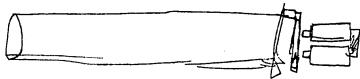


Experiments with Talking Integraph

July 6th 1876
July

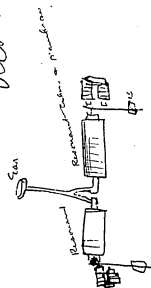


Tried a piece of felt saturated with water. Salt & water and other things all lysed out a long Brass tube Pressed Dextrum with magnet in front and Iron Armature pasted on to the Parchment got a good many words plain such as How do you do



Alonzo T. Del

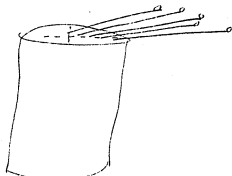
May 8 1876



One need use note higher. These rollers,
 1st part of dis-connection are used &
 the portion within are used
 the giving up rollers which
 dis-connection the type to
 read-connection handle

over which were connected lower cutting
in & out resistance experiment was tried in
very bad way & got no results but think
there is something in it.

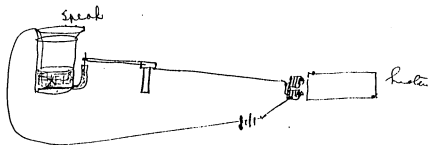
The my work



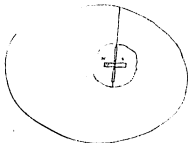
spark box

I think the high notes are made by the middle
of diaphragm only vibrating while as the notes are
lower more of the diaphragm vibrates,
hence by placing carbon points from
center to rim may get different notes &
have levers cut in & out resistance

July 26 1876
J A Edison
Good night
I am —
James Adams

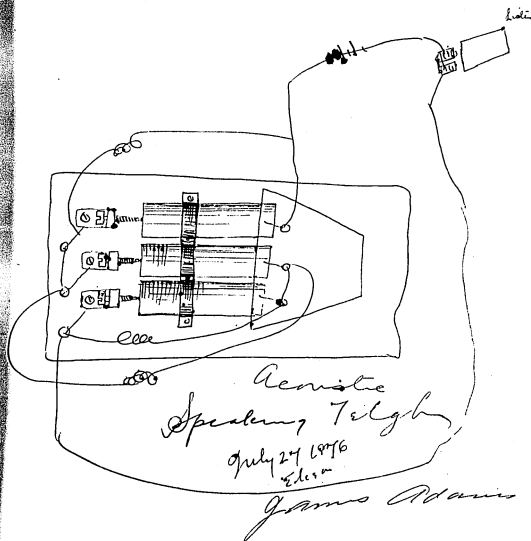


X Water & diaphragm to speaking Beaker &
 & diaphragm vibrating the quivering
 large amplitude in small side
 tube & thus increase & decrease
 the resistance giving the proper
 waves to magnet as to carry on a
 conversation =



Instead of employing a lens lens mirror
 on the needle of a Thomson. Mirror
 galvanometer I propose to employ a
 thin mirror about $\frac{1}{2}$ inch long & $\frac{1}{2}$ inch wide
 or even smaller =

July 29 1876
 J. Edison



- Edison's Exhibit 101-10 -

August 2nd 1876.
Experiments in Electric Talking Telegraphs.

Up to the present date we have tried a great many plans, a few of which are described below:

In our first experiments we found the parchment diaphragm in the transmitter could not be kept in adjustment owing to the expansion and contraction from moisture of the breath - a thin brass diaphragm was substituted which entirely overcame this difficulty but otherwise gave no better results - a brass diaphragm in the receiving instrument is inferior to parchment owing to a metallic ringing sound it gave. Tubes of various sizes ranging from $3\frac{1}{2}$ inches to $1\frac{1}{4}$ have been tried but our best results were obtained with a two inch diaphragm brass in transmitter parchment receiver with 3 ohm spool 2 cups

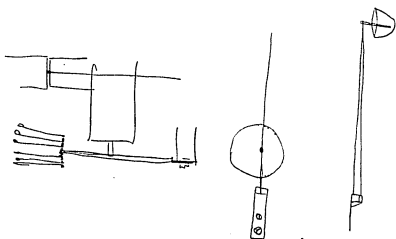
- Edison's Exhibit 102-10 -

of carbon short circuit shunting the
 sender with about 40 ohms - singing
 in any key can be transmitted accurately.
 Solid and spring contacts have
 been tried small platinum points and
 large brass discs, also discs & knife
 blade contacts with no gain.

An arrangement of one box with 5
 diaphragms of different size ranging from
 $\frac{1}{4}$ in to 1 inch, no advantage.

A box with 3-2 inch diaphragms was
 tried each working independent & connected
 so as to throw in and out resistance various
 other changes were made in the connections.

Induction, static discharge, primary &
 secondary currents - on all the above &
 on nearly all of the connections singing



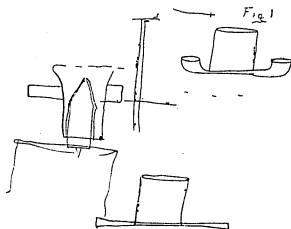
- Edison's Exhibit 103-10 -

could be transmitted perfectly - also playing on the cornet can be transmitted perfectly.

A plan which for want of perfect apparatus was not thoroughly tested is constructed on a very satisfactory plan & will undoubtedly be a great improvement. A good model will be constructed & a thorough test made at once.

A platinum wire is attached to the diaphragm & immersed in a solution or liquid resistance, the strength of the wave is by this means varied according to the amplitude of the diaphragm. Various improvements & modifications of this plan are proposed such as ~~shown~~ for increasing amplitude diamond shaped immersing point of aluminum.

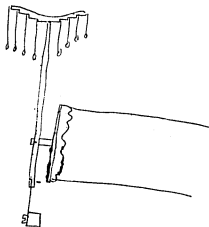
Another plan is to place chemical paper between contact points & the variation in pressure of diaphragm gives corresponding variations.



- Edison's Exhibit 104-10 -

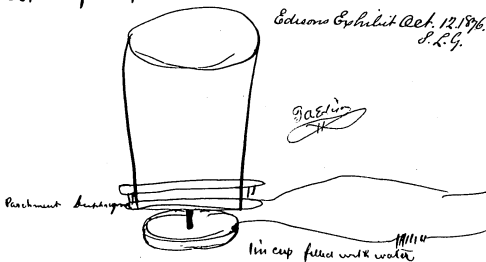
strength of wave. The sketch on the back of this sheet is a plan proposed by Edison & will be tried in due time. The introduction of saturated felt in place of chemical paper is also proposed.

The following plan will be tried at once represented in Fig. 1. on opposite page - diaphragms arranged to force out water against a counterbalancing diaphragm the talking diaphragm is placed in close proximity to metal plate leaving only small amount of solution to be vibrated. The two counterbalancing diaphragms furnish elasticity.



⁵⁻
Speaking Telegraph

Edison's Exhibit Oct. 12. 1876.
S. L. G.

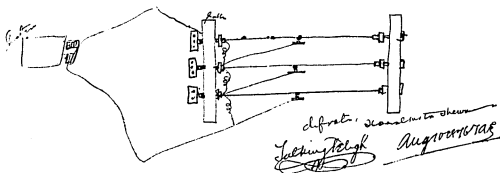
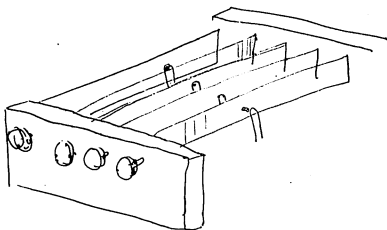


James Adams

This works but not so good as Phonautograph on hard
rubber. Uses mercury instead of water but it
is a dead make & Break

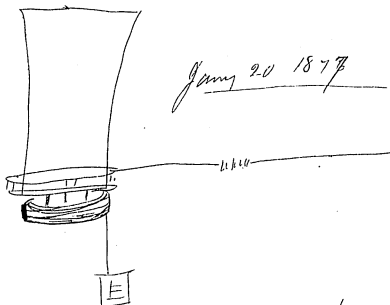
Oct 12th 1876

James Adams James Adams
James Adams James Adams
James Adams

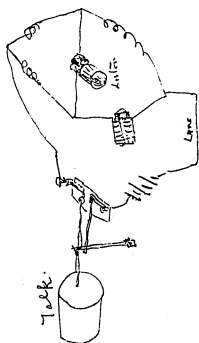


Speaking telegraph

6



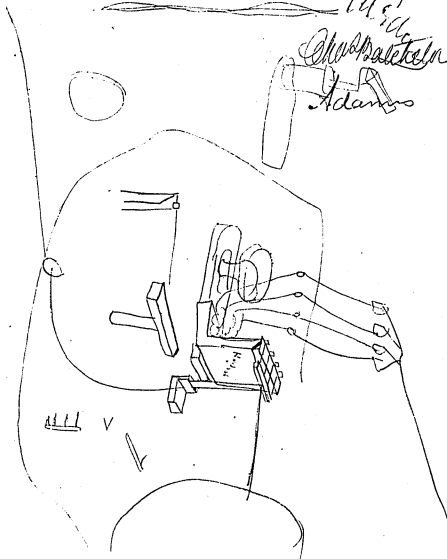
These Plating points dont seem to work any better than one point yet it very good for a western union relay through my tube. but I think that I could get it better if I had an adjustment to it for Charles cant hold it steady enough



July 6/1877
7a Edison

Wash Post Telegraph
James Adams

Specy. B. 1877 Feb 11 1877
2454
Charles Adams
Adams



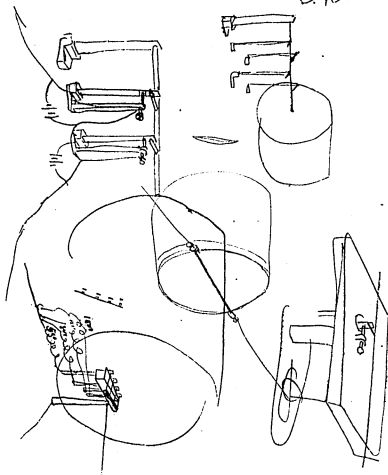
Spry Rely

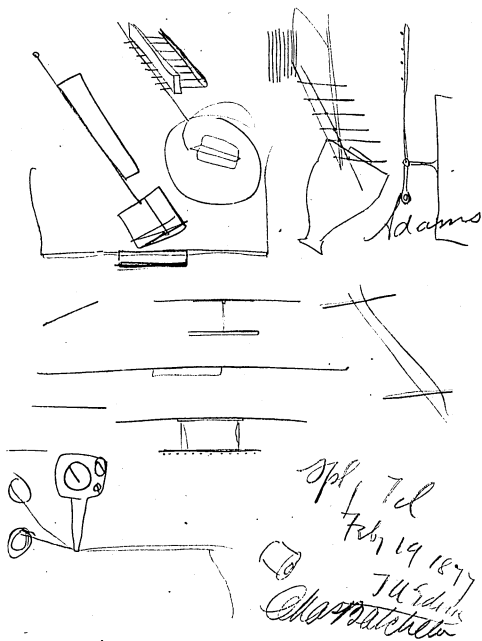
Feb 11 copy

74 Edison

Chas. Batchelor

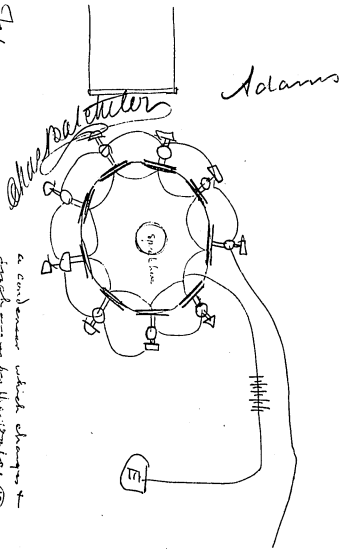
Adams

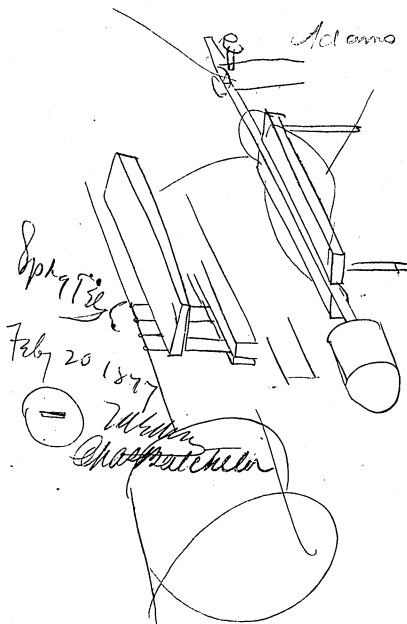




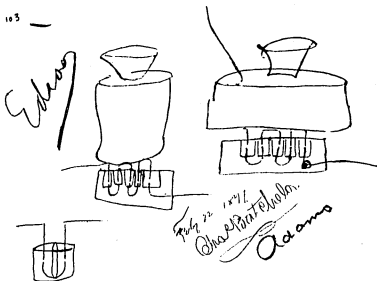
July 19, 1877
 W. & N. M.

a condenser which charges & discharges by the stroke of a lever (the incandescent lamp) together with a battery of Leclanche cells in & when the charges reach in & when the current is shut off these currents acting on the incandescent lamp on the same act as the lamp when returning in between

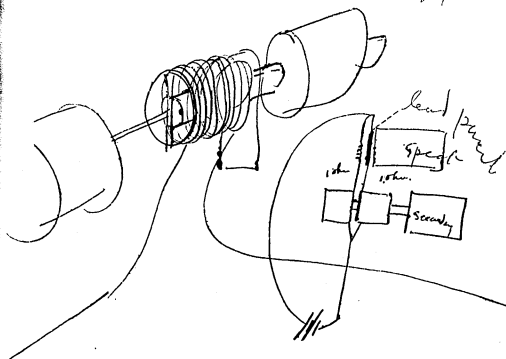
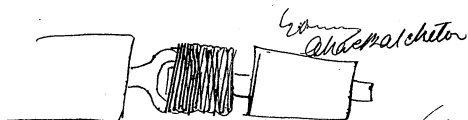




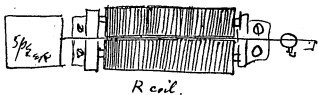
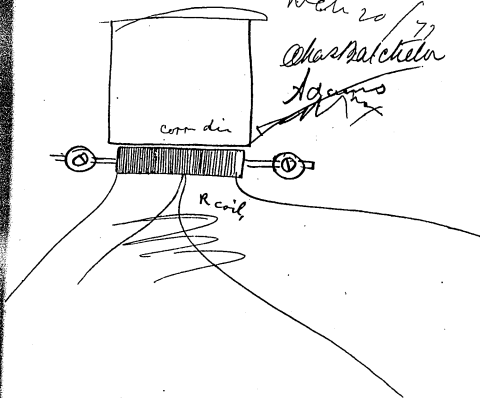
103



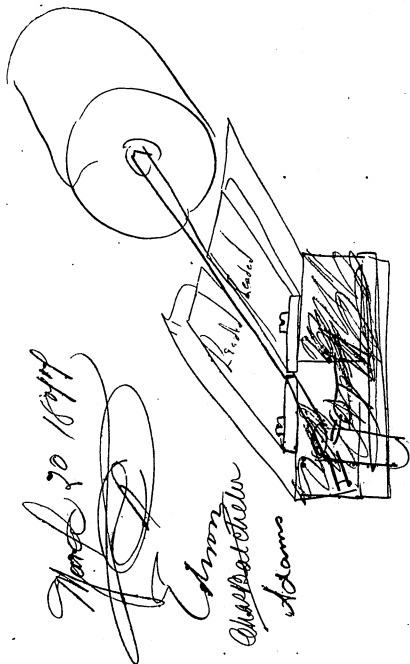
Mechanical Telegraph
 March 20 / 77

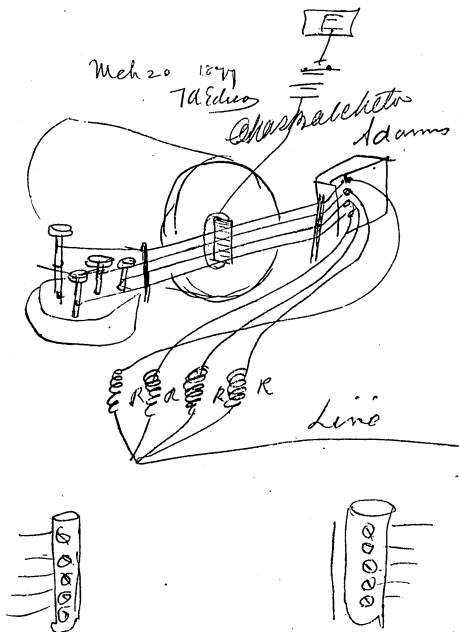


Mpky Telg
 Wch 20/77
 Charles Batchelor
 Adams

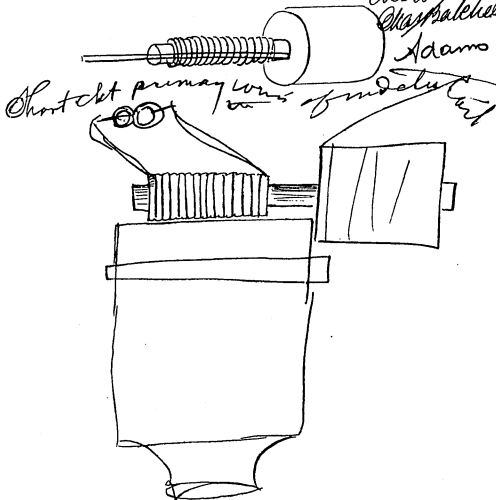


Rubber cylinder covered with
 bare galv wire & vibrating



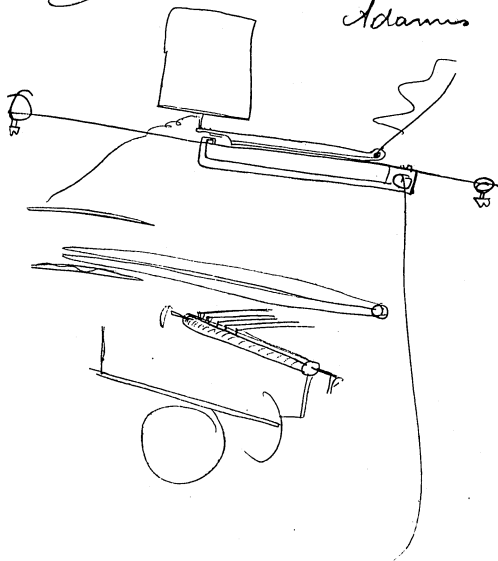


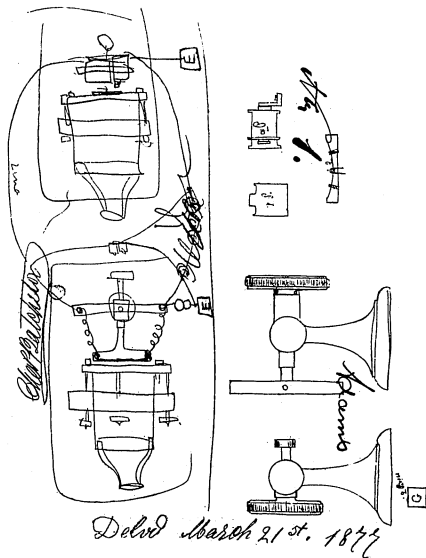
Speaking Telegraph
Mch 20 1877
Wm
Chas. B. Leake
Adams

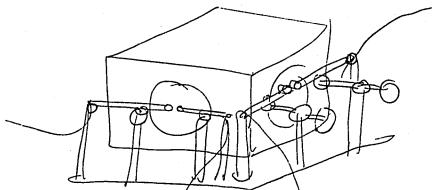


Speaking Telegraph
March 20 1877.
Chas. B. Alcheltor

Adams



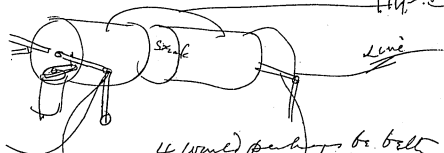




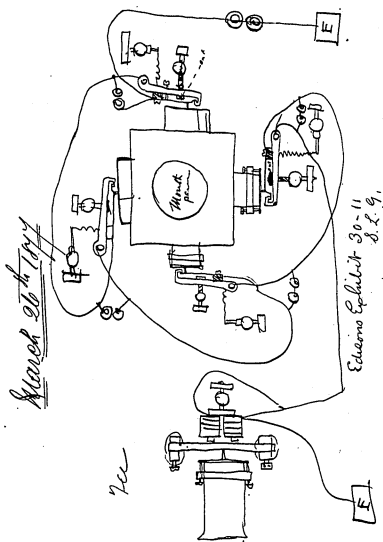
Wch 25 1007

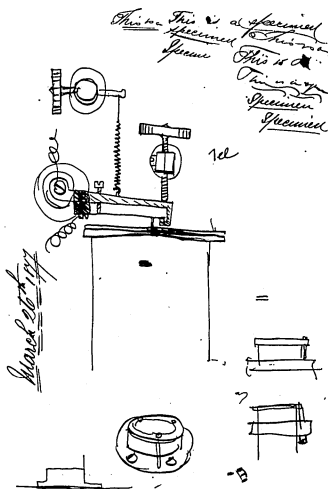
W Edison
Chas. B. Alcheta

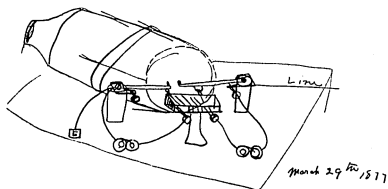
744. [Symbol]



if would perhaps be better
The two give very fair speaking
between the two Merle Parkson.
no 8 8000 W W W I

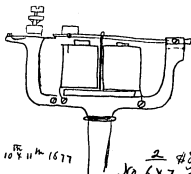






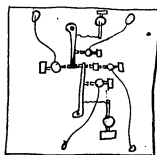
No 5 Model \$12.00

Adams



Delivered Apr 10th 11th 1877

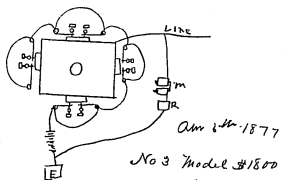
No 6 7 $\frac{2}{3}$ \$8.00 East
~~\$8.00~~



No 8 \$12.00

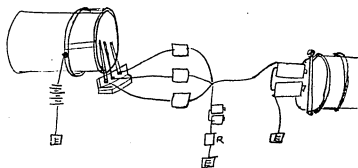
Apr 12th 1877

Adams



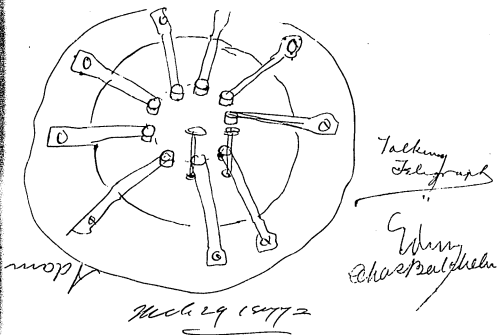
No 3 Model #1800

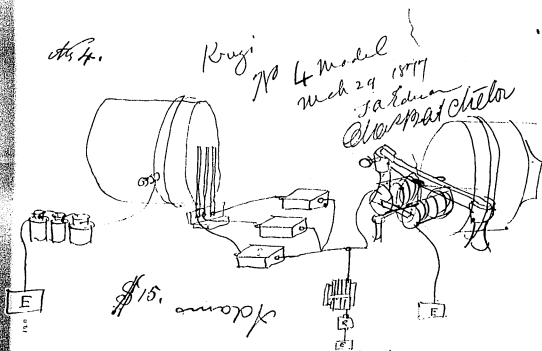
A Adams

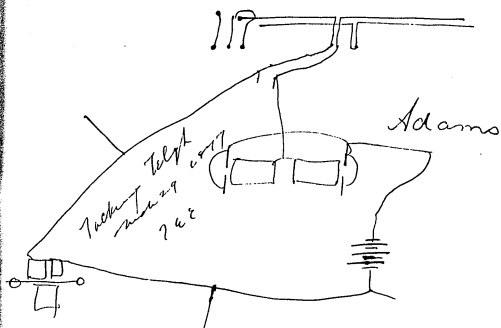


No 4 Model #1500

A Adams







~~44~~ 5.

Krug

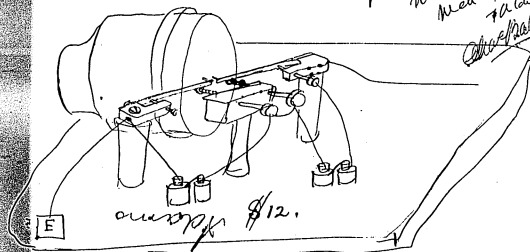
~~44~~ 2

Model

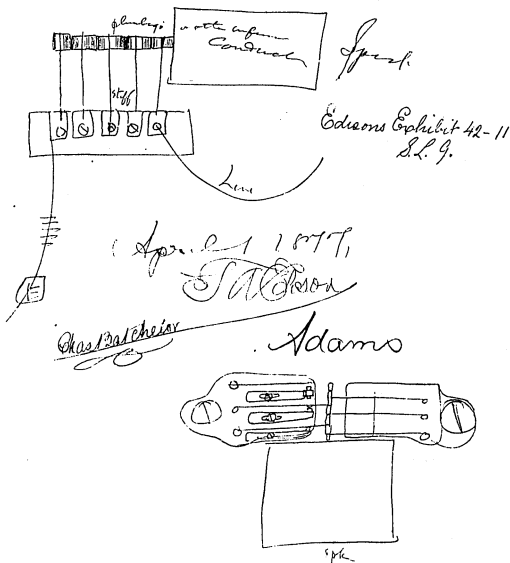
Feb 29 1917

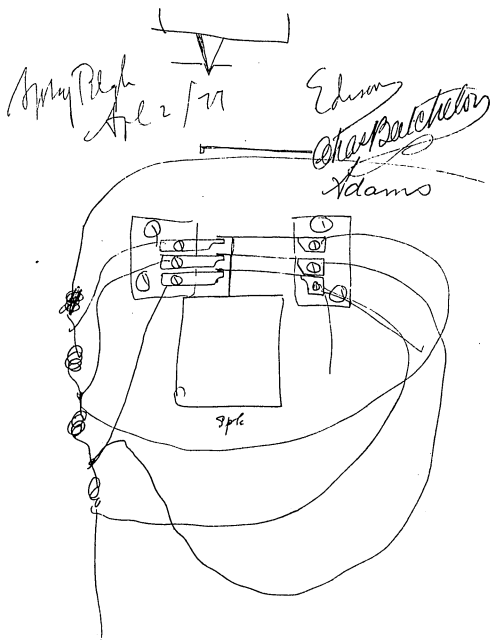
Walden

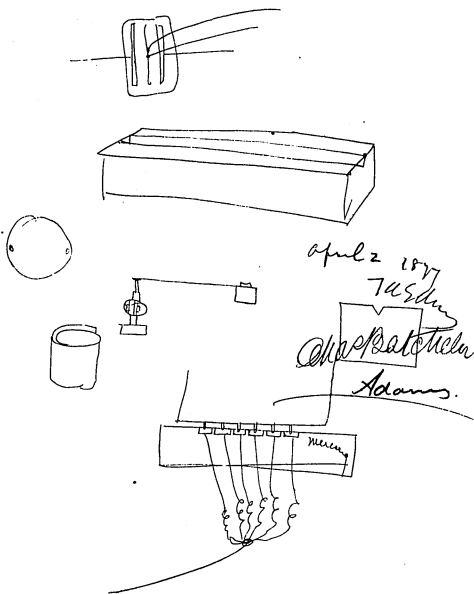
Chas. F. Ralston



over \$12.

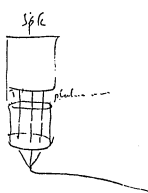
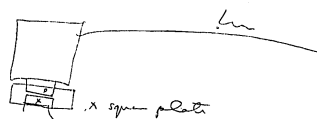
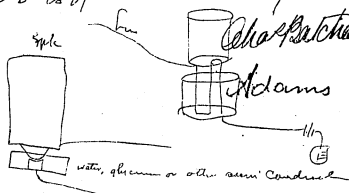




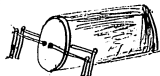


Spiegelberg
Vol 2 1887

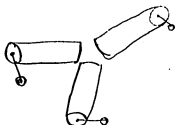
Edison



Quelon 0003
3500



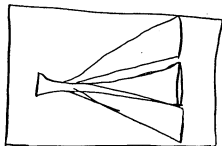
Disk with prints
on both sides



Small Rev engine tubes ?
With Bk Hide Manganese
Pinks

Edison
Wm. B. Chetani
Adams 316

April 30, 1877



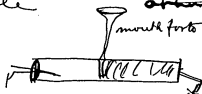
End to talker



Seven small tubes
with one diaphragm
over the whole



End
mould for talker



Whisper at one end will make it loud at the
other
on the principle of the speaking trumpet

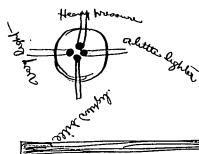
Nov 5th 1877

Edison

June 5th 1877

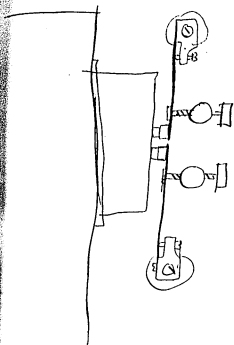


Plumbings one inch long and 1/2 inch across the face



This is Edison Charles Batchelor James A.

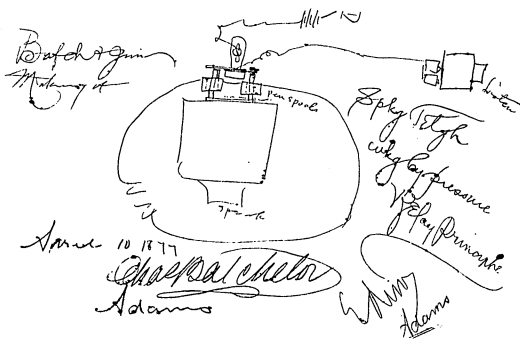
EDISON'S EXHIBIT. 56-11.

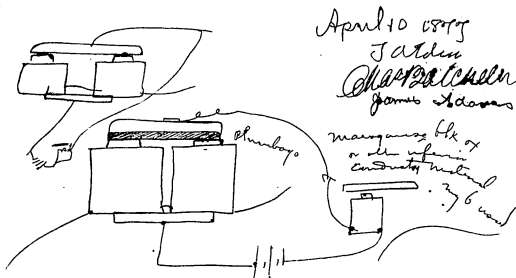


Am 3rd 1877

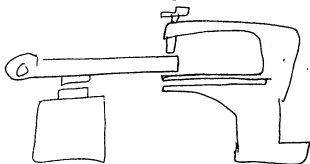
Model 3 Adams
No 3

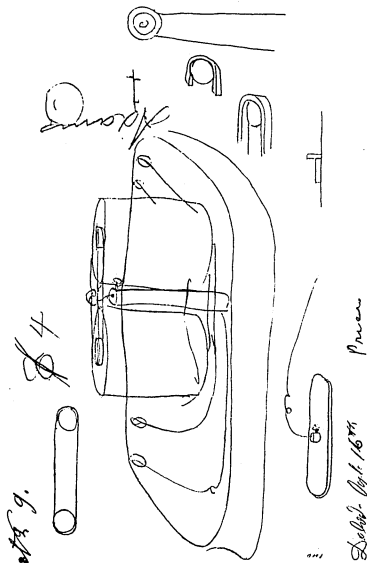






Pressure Relay



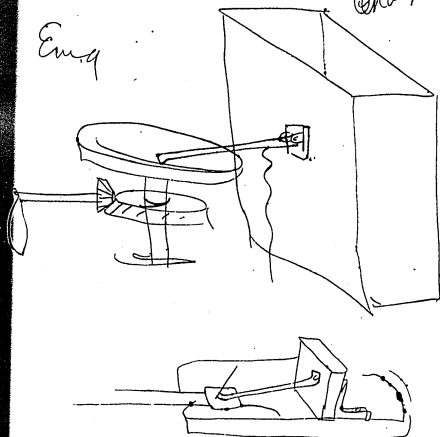


Apr 15th 1877

Pressure Relay Sply 72 James Adams
 Tartrate of Iron no good
 Bismuth no good
 Iron by Hydrogen no good
 Phosphate of Iron no good
 Oxide Lead to good a conductor
 Nitrate Iron no good
 Oxygen Oxide Lead no good
 Carbonate Silver works but not so good as
 Black Lead
 Sulphate Lead no good
 Oxide Copper no good
 Arsenate Iron no good
 Iodate Plumbum no good
 Iodate Copper to good a conductor —
 Works fair
 Iodate Copper & 2 Parts Black Lead 2 Parts
 Works red hot
 Iodate Iron no good
 Cyanide Silver no good

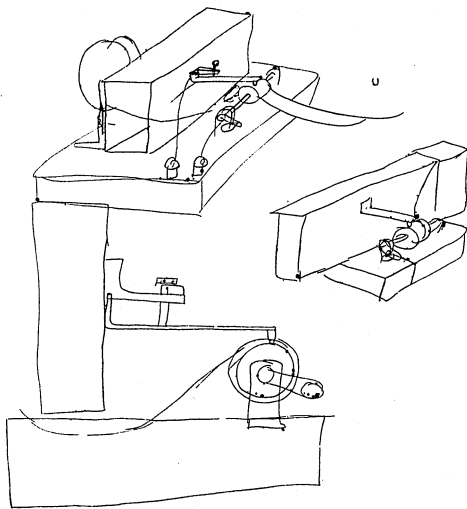
181

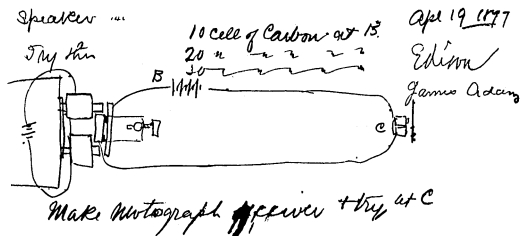
April 18. 1877
Emg. Spkng Tel Recr. (J. Adams)
James Adams
Chas. Batchelor



1874
E. S. Telgh

April 19 1874
J. A. Edison
Chas. Batchelder
James Edison





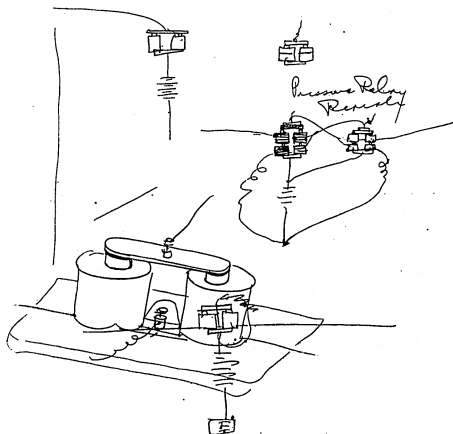
Spring Relay

April 20 1878

J. E. Adams

Chas. Batchelor

James Adams

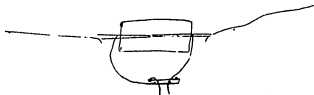


Spq Telegraph

April 23 - 1877

J. A. Edison
 Chester B. Atchison
 James Adams

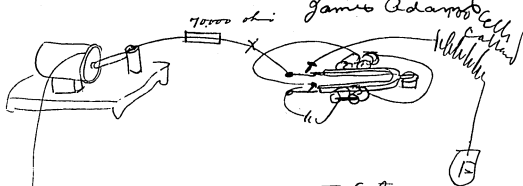
W³ got the best speaking from shield from
 diaphragm about 2 inch diam
 with $\frac{3}{4}$ inch surface round point of
 pressed black lead fastened to a
 $\frac{3}{16}$ inch steel spring with screw
 with $1\frac{1}{2}$ inch of center of plumbago
 & Resonant in Ear (10) Resonant
 box with spq in center leading to &
 resting upon Cheam paper
 moved by diaphragm & belt wheel
 The springing with rigid platinum
 point instead of plumbago, is amazingly
superior - It is quite probable that key
 for speaking Telegraph something can
 be found better than plumbago



April 24 1887
J. Edison

~~Chas. Batchelor~~

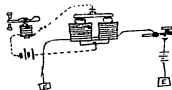
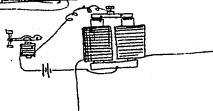
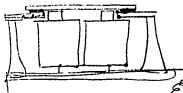
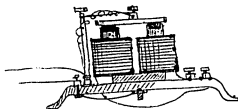
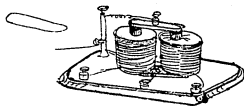
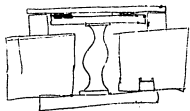
James Adams ^{cells}
Calvin



(4) Or Even not connected to Earth but
to big pen iron -

The diaphragm gives the vibration when
the disk of plumpago is adjusted
near it is apparently attracted
- This is apparently an tension attraction
if key would it ~~X~~ be open
no vibrations are heard of all
diaphragm =

EDISON'S EXHIBIT. 86-11.

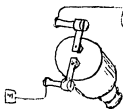


From Relay
May 10 1877
Zak
Chas. Peckham
Jama N. Y.

EDISON'S EXHIBIT. 87-11.



May 16 1877



Chas. Batchelor
James Edison

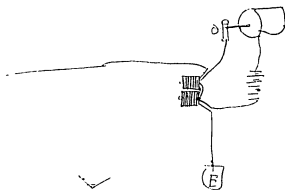


May 16 77

107

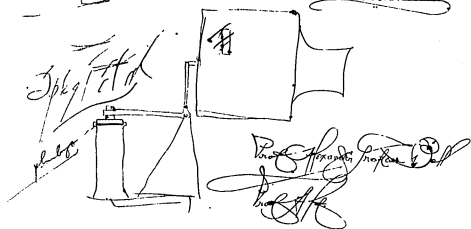
Spk g r d f

May 21 1877
J. H. Adams
~~Chas. B. Adams~~
James Adams



U
U

Draft
Draft



Speaking Telegraph

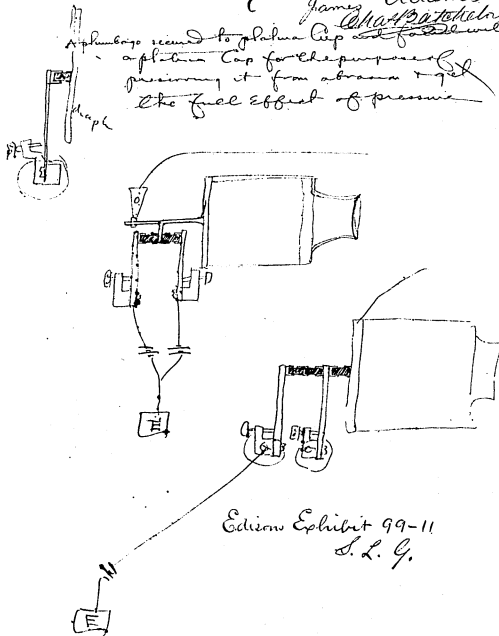
May 25 1877

J. A. Adams

James Adams

Charles B. Adams

A phonautograph record to phonautograph cup and fasten with
a phonautograph cup for the purpose of
pressing it from a brass ring
the full effect of pressure



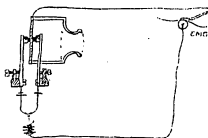
Edison Exhibit 99-11
S. L. G.

Talking Machine

May 22, 1877

To Mr. G. B. Batchelder

James Adams



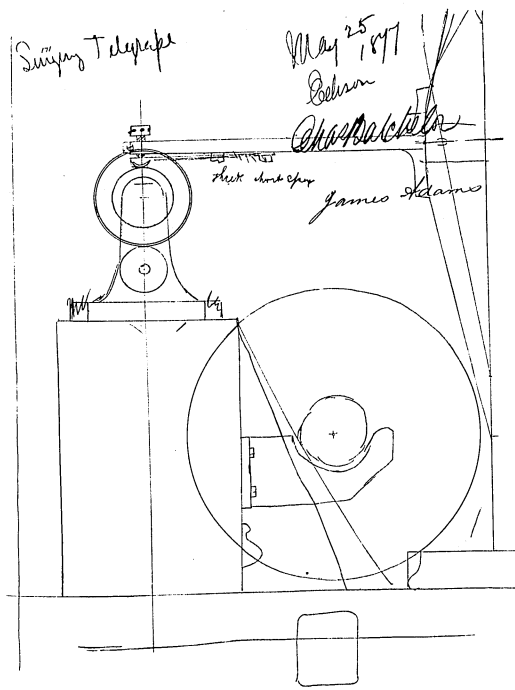
Singing Telephone

May 25 1877

Edison

Chas. B. Ketchum

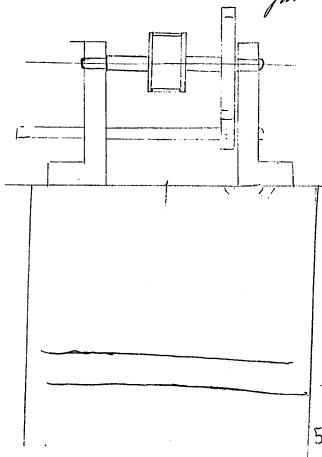
James Adams



Shipping Telegraph

May 25 1877
Edison

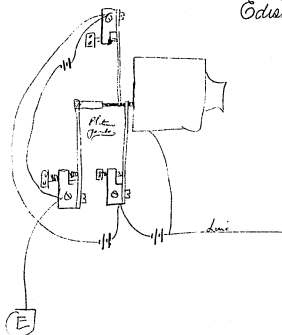
Chas. P. Tate
James Adams



150
Speaking Telegraph.

May 26 1877
J. A. Edison
Chas. Batchelor
James Adams

Edison's Exhibit 106-11.
S. L. G.

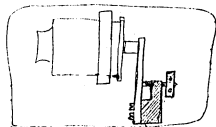


1894
Speaking telegraph

Edison Exhibit
111-11 Sept. 1894

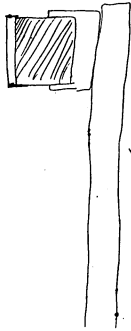
May 29 1894

James Adams



P. Phosphate

Platina faced. to prevent abrasion



actual size

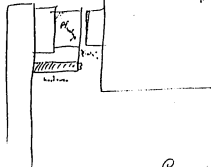
Perhaps this Spring is too thick
but that will depend upon its
length =

Sprague & Tilly

May 31 1877

Edison
Chas. Batchelor

for Adams



Edison's Exhibit 112-11
S.L.G.

Speaking Telegraph

May 31st 1877

57 Cells Calland Battery

J A Edison
Chas. B. Dethlefsen

Experiments to determine the availability of Plumbago mixed with different substances in a disc which by variable pressure shall give us variable resistance. 5 Gramme weight has piece of platinum 1/4" 3/16" diameter. The blocks are all 1" thick

	5 gramme weight	1/4" 3/16" 5 gram	thickness
1 Pure Plumbago	45 ohm	45 ohm	5/8" 100 days
2 Plumbago 66.6. Gelatin 33	acv 10,000 ohm	200.	1/2
3 Plumbago 66.6. Gum damar 33.33. Linseed oil	200 -	45 -	3/8
4 On a second test of Plumbago 66 Gelatin	2,000	—	1/2
5 On a third test of Plumbago 66 + gelatin 33	1400	400	1/2
6 Plumbago 66 Plant Paris 33	over 10,000	100	over sensitive!!!
7 On a second test	over 10,000	100	1/2
This has more than 10000 probably 20,000 ohm			
8 Plumbago 1/3 Carbon 2/3	100 —	100	1/2
9 Plumbago 1/3 Sulphur 2/3	over 10,000	2100 —	1/8
10 Plumbago 3/4 Sangre de Animal 1/4	400 —	100 —	5/8
11 Plumbago 1/2 Sugar 1/2	10,000 —	100 —	1" —
12 Plumbago 1/3 Tragacanth 2/3	200 —	30 —	1/4
13 Plumbago 1/3 Glycerine 2/3	10,000 —	400 —	—

This is exceedingly variable sometimes a very 10000 then goes to 1000

¹¹/₁₆ Dunlap ²/₃ Sulphur ¹/₃
 This has probably 100,000 ohms with 5 gm
 and about 40,000 ohms with 14 grammes.
 Sometimes by a little pressure I can
 be brought down to 20 or 30 ohms but
 it is not reliable

Adams

Speaking telegraph

June 9, 1877

~~Edison~~

Chas Batchelor

We now put back Plumbago & Singlas
in large draughtman sander but no good
at all

James Adams

Speaking telegraph June 2nd 1877
 J. A. Edison
 Chas. Batchelor

Tried our new speaker ~~made of~~ ^{made of}
 Cast iron cylinder with diaphragm
 6 in on solid iron base and
 plumbago disc 1ⁱⁿ diameter but
 it evidently is not so good as
 former experiments with less dia-
 phragms so

We put in ~~an~~ instrument with 1 3/8 dia-
 phragm and got better results

This with pure plumbago was good

" " Plumbago + sugar no better.

Plumbago + Sulphur no good at all

Plumbago + Lamp glass test yet

We now took away cylinder from
 receiver + left the diaphragm standing
 + found we received better

Speaking tetrapodJune 6 1897
Edison
Chas BatchelorNo
154

15 Plumbago \$1 per lb. James Adams
 previous plumbago used by us only 6¢ per lb.
 greatly adulterated — — —
 Articulation 125 could not get the
 buckling out whether we had it far
 away or close up. Tit clean

150

is now put in this number again

15 Plumbago & 11 Rubber
 & altered the diaphragm by putting in
 one made of copper foil with a piece of
 sheet brass $\frac{3}{4}$ diameter soldered on to it &
 a piece of thick sheet platinum $\frac{1}{2}$ diameter
 soldered on to that

This makes the diaphragm very flexible
 in some parts and heavier in others

Articulation 129 Great margin for
 adjustment No buckling, very good

156

4 Plumbago 2. Barb Magnesia
 Good. Articulation 129

124²⁷ Plumbago 4 Amalgam 4 - June 26,
 Articulation 125 Very low ^{acting} no tuskling

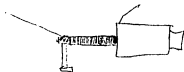
135 Per oxide Lead test + Plumbago shank
 No good James Adams

36 4 Plumbago $\frac{150}{N 6}$ Fine clay
 Very good 130 All right for ordinary
 Conversation Very good



42

Edison
Edison



disk of thin metal, having an
 inferior part of surface
 and packed together the
 vibration of the disk is
 deriving to give better contact;

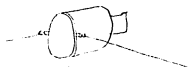
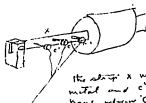


Diagram of Vibration or
 the vibrating Disk.
 & connected with Plumbago or
 Tapered metal surface conduct
 it to the disk. The only way
 of the displacement in spring
 will make an & clear view
 The strength of the (spring)

June 4 1877

J. Adams

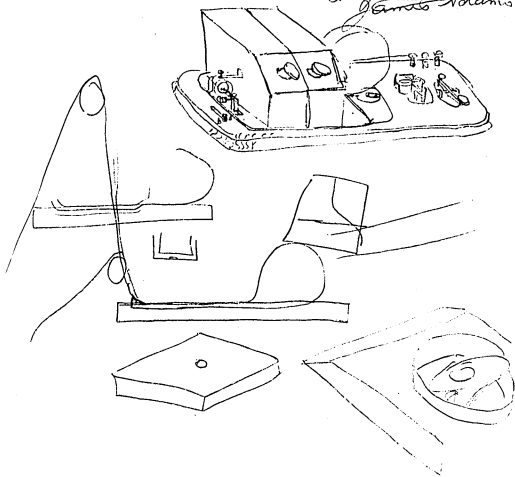
Edison
Edison
James Adams



The strip x may be of
 metal and c & e may
 have inferior conducting
 tips or the strip x may
 be of inferior conducting
 material with an inferior
 conducting surface
 or c & e of metal.
 It can have any "points" with
 strip may be of any length

200
Spka Telegraph

June 7 1877
J. D. ^{Edison}
Chapman
James Adams



EDISON'S EXHIBIT. 132-11.

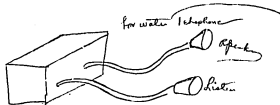
201

Edison's Telegraph

June 1st 1877

S. A. Edison

Chas. Batchelor



Then present

Speaking Telegraph

June 13 1877

7 A. Edm.

Chas. Patchelor

James Adams



Tests of pressed plumbago and
other substances to see which is best
for speaking

The sticks pressed are this side

 Some buckling accompanies it when adapted at
any distance from diaphragm - call it 100 -

Pure Plumbago - Very difficult to understand
an unknown sentence although it sounds well
when you know the sentence before hand

15 Gramme ~~Plumbago~~ ~~2.5 Gramme~~ ~~Plumbago~~
good about 110 -

No 93
15 Gr. Plumbago 7.6 Gramme Dextine
about 110 - Articulation pretty good
15 Gr. Plumbago 2 Gram Coach Body Kanulst
articulation fair but inconstant
about 108 No 90
over

that the platinum point on the anaphragm
is too small, smaller than the bit on
end of Plumbago this must be
remedied

15 Plumbago & 2 Kaolin fair about
90-85 115 & seems to be a little variable

15 Plumbago & 2 Gelatin fair but
85 only 115. It is not very loud

15 Plumbago & 2 g Tannin
89 wheasy & rattling about

112 No 86
15 Plumbago & 4 Salt—
—95— very rattly

109 91
15 Plumbago & 2 Balsam Fir
came rattly & then weakened
right down
1104

Speaking Telegraph

June 13th 1877

7 A Edison

Chas Patchin

NO 87
15 Gram of Plumbago dissolved in alcohol
good work about 115
2 Gram Resin
James Adams

NO 84
15 Gram Plumbago + 2 Gram Singlass
dissolved in Acetic Acid
pretty good about 115
still seems to be in constant

We now put in another diaphragm
made of shield brass with a small
plated point in middle

Unknown Plumbago mixture simply elegant
at least 125. It now becomes necessary
to find out what this combination is
we believe it is. Plumbago with a large
proportion of Singlass or Gelatin

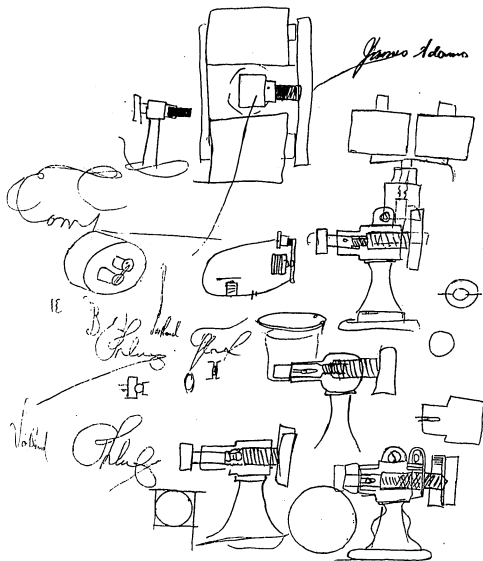
NO 83
15 Plumbago + 2 Soft Rubber dissolved
in Benzene + Carbon very good
at least 125. On this we got whistling
and whispering perfectly

There is one difficulty yet and that is

206

magelouche

June 14 1877
J. A. Johnson



¹⁰³ Spradling telegraph
Continued

June 15th 1877

J. A. Edison
Charles Batchelor

James Adams

No 8

Comp. 4^g. Plumbago 750 mg. Sulphur
Exceedingly variable but when it does work
it is equal to 125. Got whistling but in
whispering

No 121

Comp. 15 Plumbago 6 Sulphur in Bi sulphide
of Carbon — Very variable indeed
But when it comes at all it is equal to
125

No 95

Comp. 15 Plumbago 72 Balsam Fir
This I think is the best we got it is equal
to 126 in articulation but I fear it is
inconstant though it did not show it
greatly. The whispering was the best
we got

See No 91
something wrong

We sing a song and could plainly
distinguish the words though this
was the first time we have tried it

No 83

Comp 15 Plumbago 4 Sulphur in Bisulph-
ide of Carbon very good Articulation equal to
126 We fear it is a little inconstant

Speaking Telegraph

June 15th 1897

Same continued —

No. 111

^{James Adams}
^{Edison}
~~W. H. Pritchard~~
equal to 125 as good if not the best we have had yet can get the whistling but not whispering. Composition 1500 gram. Ininglass dissolved in 4 grams Acetic Acid. The platina cut into the the composition a little. No spark holes made.

We now put in a diaphragm with a piece of platina on centre a little larger than the tit on Composition

No 110

Composition 15 Plumbago + 2 Woodbridge Clay. Very good but it is inconsistent it stands when it does work 125. Can get the whistling only by a fine adjustment. No whispering.

No. 98

Comp. 15 Plumbago and 4 Bermuda Anaroot. Very good 125. Could get whistling and whispering good.

No. 130

Comp. unknown equal to 125. Got whistling and whispering well.

²¹⁰ Speaking Telegraph June 15th 1877

James W. Adams ~~Edison~~ Batavia
 No 104 Comp. 15 Plumbago + 4 Balsam Fir
 Very good equal to 126 articulation
 particularly good and seems constant.
 whispering not very good.

No 116 Comp. 15 Plumbago 2 Starch
 articulation very good but very rattly
 equal to 124. Whispering best we have
 had yet seems like talking
 He got the sh!! all perfect on this

No 118 - Comp 15 Plumbago + Cellodion in unknown
 quantity very satisfactory no indeed
 apparently very constant
 He thinks we must make this
 equal 128. for it appears best in
 everything

14 Comp 4 Plumbago 250 Hg Sulfate
 of Barite.
 articulation very good we think this is
 equal to 128
 Whistling good
 Whispering good
 Continuity good

Speaking Telegraph

June 15 1877

continued

J. A. Dasso
Chas. B. Batcher

James Adams

No 12 Camp 4 Plumbago 250 m. g. Fire Clay
 Think it constant not absolutely pure
 Whispering good
 Whistling good
 Think it equal to 129
 Articulation excellent

No 85 Camp 15 Plumbago 2 Naolin
 Think it constant but only equal to 126
 Articulation fair this was about 111 before
 the diaphragm was changed

No 105 Camp 15 Plumbago 6 Naolin
 Think it constant but only equal to 126
 Get the whistling and whispering
 Possibly it may be in constant

114 15 Plumbago 6 Stock
 Think it extra good on lowest finest
whisper. It is perfectly constant
 Articulation most perfect
 it equals 128
 Lowest talking comes best
 The set is not altered in the least
Really good !!!

⁵¹² Speaking Telegraph June 15 1877
Tadlow

Charles Batchelor
James Adams

No.
104

15 Plumbago 2 Gum Distillate
Inconstant & not equal to more
than 110

103

15 Plumbago 2 Bk Asphaltum
Articulation very good indeed
Could not get the whispering
Articulation appeared a little better -
Stant, it equal however 126

92

15 Plumbago 2 Balsam Caplar
So inconstant that it is positive
is good at all -
The most inconstant one yet
when got it is NF
The comp. is very soft unphor

Speaking Telegraph

June 16th 1877

Edison

James Adam Chaperonator

102

Comp 15 Plumbago 2 Venice Turp
fair about 125

Fit perfectly clean

Articulation good but not so good
as some.

Appears constant.

101

Comp. 15 Plumbago 2 Oil Cade

About 123 for articulation

It is however very strong and constant

Fit perfectly clean

Very soft join. notice it pulling it out

15 Plumbago 2 Arrowroot

117

Articulation is 128 on this when low
especially on whisperingAt no time was it very strong —
Platina & had no hole in it.

97

15 Plumbago 2 Woodbridge Clay

Articulation weak but 126. (breaks in
flakes)
whispering poor & whistling good
soft broke coming out — Fit clean

Spear and Telegraph

June 16 1877

Edison

John Batshelor

James Adams

No
112

Comp 15 Plumbago 4 Naolin

Not as good as as Plumbago pure
 about 98 This probably has not been
 pressed properly as we have had
 good results from Naolin before

16

Comp 4 Plumbago 250 mg. Borate of Baryta

Good articulation 12% Good generally
 but not the Good we are looking for
 It is clean

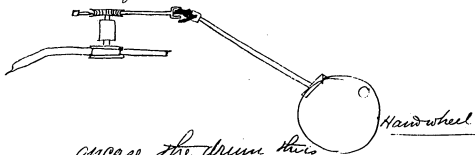
215
Speaking Telegraph

June 14 1877

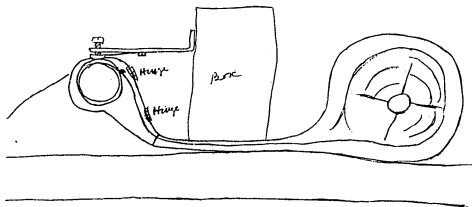
- Enos
- Chas. B. Felt
- James Adams

Alteration on Model Speaker -

Carry the shaft at an angle so as to bring worm on other end of shaft & put drum on end of shaft and encase like drum on receiver of Domestic Tel Co. thus: -



encase the drum thus



213

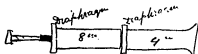
Speaking Telegraph June 17 1877

Edison

Robert Battecher

James Adams

In testing compositions we put two instruments together this



In doing this we noticed an improvement — it raised the note to a high one that is when Jim talked low we got it very high — but it seemed to have extra noises in —

We tried talking at a diaphragm through tubes of different lengths but found no perceptible difference

In showing the speaking telegraph to Prof. Barker we used no 114 Numbago & after using it some time today we find that the it was roughened considerably showing it was a little unreliable.

15 Comp. Numbago & Oil Spruce
very poor when it comes to articulation
is about 125. It all roughened up
very rattly weak and uncertain

Speaking Telegraph June 14, 1897

Edison
Charles F. Smith
James Adams
Flou

- 87 Comp 15 Mumbago 2
Got scarcely altered —
Articulation 118 weak and very uncertain
- 89 Comp 15 Mumbago 2 Fannin
So weak we could not place this at any figure
It not altered at all!!! Strange!
- 120 Comp 15 Mumbago 2 Water with Fly
No good at all it kills entirely —
not all roughness up.
- 1 Comp 4 Grams Mumbago 1 Gram Ph. carbonaceous
of Lode
Bad no articulation and weakens right down
- No 106 Comp 15 Mumbago 2 Balsam Fir
Constant about 128 and loud
It not altered

Speaking Telegraph

June 14 1847

Edison
Chat. B. B. B.

James Adams

No
18.Composition 4 Plumbago 2 Fire Clay
Fe. turnedvery poor about 95could get nothing good whether we talk
loud or lowNo
110Composition 15 Plumbago 2 Be Carb. Soda -
could not get anything at all but occasionally
a closing of circuit
equal to 0No
119.Composition 15 Plumbago 6 Woodbridge Clay.
Very poor about 15No
109Composition 15 Plumbago 9 Woodbridge Clay
very strong at first and dwindles right out so that
after 2 sentences it is nothing more than a hum.
Jim says that after he had said a few words
the Plumbago seems to hug the dia phragm &
won't leave
This is no good at allNo
2Composition 4 Plumbago 10 Be Carb Soda
works right down - no good - fearfully
hastily, in constant, when it comes about like
100

²¹⁹ Speaking Telegraph

June 18 1877

Edison

Chas. A. Tekela

James H. Atkins

4 Flour

113

Comp. 15 Plumbago

In constant in good

Articulation 125 when good
fit roughened up

138

Comp. 15 Plumbago & Camphor in alcohol

Articulation 125 but rattly and when adjusted
as is not to rattle no articulation
Fit turned

Comp. 15 Plumbago & H₂O 1 Gelatin -

106

Articulation fair but too low to be any good
about 110 when it comes ~~down~~
Fit scarcely altered.

90

Comp 15 Plumbago & Beach body varnish

Articulation 129 constant. Could could
read it through 10000 ohms
Fit roughened up

No
87

Comp. 15 Plumbago & Kiesel 3 Alcohol

Articulation 129 Constant & strong

Speaking Telegraph June 14 1877
Edin

16 Comp 15 Plumbago 4 ~~Charcoal~~ ^{James Adams}
132 2 Resin
Articulation good about 125 but
with a grating
It worked up

96 Comp 15 Plumbago 4 Starch
Rattly. weak articulation 100
It altered a little -

16 Comp 15 Plumbago 4 Dry Salt
86 Rattly light, & about 100 -
PHENOMENON The composition was
as holes & had all the glass from the press
taken off it since moulding by atmosphere

93 15 Plumbago 6 Dextrose -
129 first class Constant rattling
It whistles whistling
It all worked up

Spartan Telegraph

June 17 1877

~~Adrian Backlund~~

James Adams

- No 3 Comp 4 Plumbago 500mg. Bi Carb Soda
Scratchy but started off quite good -
played right out articulation good
about 125
T.T. roughed up

- No 15 Comp. 4 Plumbago 750mg Sulphate Baryta
Poor, weak & scratchy
about 140

- No 115 Comp 15 Plumbago 2 Sulphur des in Baryta
Poor, weak, & scratchy
about 100
T.T. clean

- No 136 Comp 15 Plumbago 500 mg. Bi carb Soda
Poor weak & scratchy
about 65

No hit on Plumb.

This soda keeps up its reputation for
being constantly poor

"Speaking Telegraph" June 14 1897.

No
14

Comp 4 Plumbago ^{Explan}
~~Chas. Batchelor~~
James Adams
19 500mg Fin clay
did not get enough over the wire to
pass an opinion on it
0 it very clean

No
123

Comp. 15 Plumbago 2 Shellac
Articulation 125 good at first but
fatty towards the end
it is all burned up it was ^{spoiled before} we used it -

No
151

Comp 15 Plumbago 2 Coarctaceous
Articulation 129. Whistling whispering
and talking all at the same adjustment
it is roughened up a little.

No
6

4 Plumb. 200mg Sulphur
Good articulation if it was not
for the cattering (wear) but
about 120
it pretty well burned


22.3

Speaking Telegraph

June 14 1877

~~Edison~~~~Charles Batchelor~~~~James Adams~~

James Adams

No

138

15 Mumb. 2 Sulphur

Fits are clean
absolutely nothing

13 Mumb. 2 Camphor sat in alcohol

27

Good articulation about 127
got rattly as it went along

227

Speaking Telegraph

June 17 1877

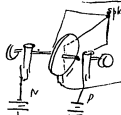
J A Edison



James Adams

with the second tube & diaphragm the

talking comes in a higher key apparently an octave higher
 Adams says the sound given out when the diaphragm
 strikes the plumbago is higher with speaking in the 2nd
 tube than when directly - and the talking is not
 so good - by lengthening out the regular tube it
 appeared to come better but after careful test the
 adjustment was found to be inferior to the
 regular 8 inch tube =



This may work



Speaking Telegraph

June 18 1877

Edison
Chas. Batchelor

James Adams

35

4 Plumbago ⁵⁰⁰/_{H₂O} Cyanide Copper.Strong but articulation about same
as standard Plumbago 10gTil clean
9th Whistling, & whispering but no articulation

27

4 Plumbago ¹⁵⁰⁰/_{H₂O} Cyanide Copper

Articulation and strength good

12g Get any thing on that

Til clean

124

15 Plumbago 6 Flour.

Very loud at first but after a little
while working with it it went right
down about 125

Til clean

56

15 Plumbago 4 Carb Magnesia

everything good Articulation 12gTil clean Whistling & whispering
good

"Speaking Telegraph

June 18 1877

Edison
James Adams41 4 Plumbago ²⁵⁰/₁₀₀ Iodine good 128

Fit clean

Got whispering & whistling ~~then~~ well

126

4 Plumbago 2 Camphor —

Camphor & Alcohol

~~This started off quick but it~~
~~drummed away~~

Articulation when it came was

125 Fit cleanW⁴⁴
44

4 Plumbago 1 Iodine

Articulation good about 128

Fit clean

Whispering was very good

It is a little inconsistent

W⁷¹
71

4 Plumbago 2 Carbonate Magnesia

Very good Articulation 129 —

Fit clean —

This was very loud so much so that
I had to have Jim speak low & then

the articulation was beautiful

I think perfectly constant

The best tonight so far —

223

Speaking Telegraph

June 15th 1877

Edison

Chas. Hatcher

James Adams

250 No. Broadway N. Y.

J. J. Tannin

No

68

Composition 4 Plumbago

Very good articulation about 128

Whispering good & Whistling also

Til clear

I noticed that Tannin did not work well when we had it in before

No

125

Comp. 15 Plumbago 6 Dry Salt

Very good articulation 128

Whistling & whispering good

Til perfectly clear

No.

89

Comp 15 Plumbago 2 Tannin

The articulation is good about 128 got several sentences consecutively unknown

Til not altered; best whispering we have had a little rattle

No

Comp 15 Plumbago 10 Rubber in 13 Sulph.

Current exceedingly weak due no doubt to the great resistance from such an amount of rubber

Articulation very good but so low it could be heard with difficulty

229 *Speaking Telegraph*June 18th 1877

Edison

*Chas. B. Atcheler**James Adams*

141 Comp 15 Plumbago 4 Rubber in Sulphide case.
 5 ft clean Good articulation about
126 Whispering distinct

143 Comp 15 Plumbago 3 Rubber in Sulphide case
 Very good I think best yet
 Articulation 129 best on ordinary talking
 Very good on whispering + sometimes
 5 ft clean

144 Comp 15 Plumbago 6 Rubber
 Very good
128 5 ft clean

146 Comp 15 Plumbago 1 Rubber
 Very good
129 Articulation — comes best when
 talking low but can be made to come good
 in any talking tit turned a little,

145 Comp 15 Plumbago — 8 Rubber
 tit a little hurried
 Articulation very good equal to 125

299 Speaking Telegraph

June 18 1877

Edison
Charles Batchelor

James Adams

15 Plumbago 9 Rubber

151

Very constant Articulation 129
 Everything good. T is a little roughened
This is the one Edison likes!!!

W

15 Plumbago 7 Rubber

148

Constant articulation 129

Bulky good

T is very little altered

W.

14 Plumbago 1 Crucible Magnesia

61

Bulky. Articulation good Constant
 Strong. T is not altered 128

W

4 Plumbago 1 $\frac{500}{100}$ Crucible Magnesia

82.

Good Articulation 129 good strong
 Whistling Whispering very good
T is not altered

80

4 Plumbago $\frac{200}{100}$ Crucible Magnesia

Good Articulation 129 everything good
 Whistling & Whispering good excellent
T is perfectly clean

231 Speaking Telegraph

June 16, 1877

Edison

Charles Satchell

James Adams

No. 15 Plantago 2 Boutchou in the sugar
 No. 14 Tit a little roughened
 very good about 128

No. 129 4 Plantago / ⁵⁰⁰ Gelatin & H₂O
 with a good or best but 125
 & generally good

Sparkling Pilegraph

June 19 1877

Edison
~~Wheatstone~~

James Adams

- 26 4 Plumbago 2 Cyanide Copper.
 Loud but no articulation 100
 Does not improve the Plumbago at all
 Fil clean
-
- 127 15 Plumbago 2 Camphor. set by Edison
 Articulation 129 good all over
 Fil clean pretty constant
-
- 48 4 Plumbago 1 Sulphur
 Articulation 129 very good (change)
 Whistling and whispering very good
 Fil clean
-
- 69 15 Plumbago - 1 Carbonate Magnesia
 Excellent articulation 129
 very good indeed. Fil a little burned
 Constant
-
- 37 4 Plumbago $\frac{1}{16}$ Cyanide Copper -
 Very slight articulation not more than
 New Plumbago 100 Very strong
 Fil a little burned Loud Whistling

233 Speaking Telegraph June 19 1844

From
Charles Satchel
Garros & Adams

He now put in an ordinary parchment dia-
phragm with platinum centre & tried

No 151 15 Plumbago & Rubber
Did not work and we attuned back
& left this for some other time —

Brass diaphragm again
No 151 and put back same paper we had
last night
O.K. good

No 32 4 Plumbago $\frac{750}{m/g}$ Tho Iron
Articulation about 125 but rather uneven,
got whistling and whispering pretty good
Tt clean

No 45 4 Plumbago $1^{500}_{n/g}$ Iodine
Pretty good articulation but not above 120
in constant could not get whispering &
whistling Tt clean

No 46 4 Plumbago 1 Borate of Baryta
Articulation seems excellent but a little
momentary. Whispers & Picking are bad
Tt. clean

No	Gr	Mg	
97	2	250	Woodbridge Clay
98	2		Bermuda Arrowroot
99	2		Flour
100	2		Balsam Tree
101	2		Oil Cade.
102	2		Venus Turpentine
103	2		Black Asphaltum.
104	2		Gum Styracis
105	6		Kaolin
106	1		Gelatin - 23 grams water
107	2		oil Sperm
108	4		Balsam Tree
109	4		Woodbridge Clay
110	2		Woodbridge Clay
111	1	500	Sanguis 4 grms acetic acid
112	4		Kaolin
113	4		Flour
114	6		Starch,
115	2		Sulphur dissolved in Bisulphide Carbon
116	2		Starch
117	2		Bermuda Arrowroot
118	1		Colloidal iron - make own granulation
119	6		Woodbridge Clay
120	2		Water with PbO -
121	6		Sulphur in Bisulphide Carbon
122	2		Furniture Varnish
123	2		Shellac <u>Tint</u> <u>spoil</u>
124	6		Flour
125	6		Dry Salt -
126	-		Camphor Alcohol

Jan 20 1877

Charles B. Ketchum

James Adams

217	6	144	Bisulphuret Tin
70V	2		Carbonate Woremin.
71V	2		Lycopodium
72V	2		Caustic Magnesia.
73V	500		Bisulphuret Tin.
74V	750		Lycopodium
75V	750		Lycopodium
76V	1		Lycopodium
77V	500		Lycopodium
78V	5		Soapstone 15 phgs
79V	1	500	Valerianate Zinc
80V	1250		Caustic Magnesia
81	4		Soapstone 15 phgs.
82V	1	500	Caustic Magnesia.

Jan 20 1877
 W. Edison
 J. H. P. P. P. P. P.
 James Adams

83 The following are all 15 grms of Plumbago.
 84 made by quin = tried them =

83V			Sulphur dissolved in Bisulphide Carbon
84	2		Sulphur dissolved in 6 grms Acetic Acid.
85	2		Kaolin
86	4		Dry Salt
87	2		Rose in 3 grms Alcohol
88	2		Gelatin - 2 grms Water.
89	2		Tarmin
90	2		Coat body Varnish
91	6		Balsam Fir
92	2		Balsam Copal.
93	6		Dextrin
94	2		Carbolic Acid dissolved in Bisulphide Carbon.
95	2		Quin 15 = natural kind
96	4		Balsam Fir
			Starch

110	G	114	
127	2	500	Campfire, unlimited 1st Alcohol. I am made the
128	2		Dry Tail
129	1	500	Galatin - H ₂ O
130			The Unknown that got good speaking from
131	2		Ca oulehouse, that got <u>best looking with</u>
132	2		Rosin
133	2		Campfire, sat Alcohol
134	6		oil Spence
135	1	500	Where are the 4 from p 60
136	1	500	Sulphur
			Bicarbonate Soda
137	1		Isinglass = 2 a cake Gold in 15 p 60 - 70
138	2		Sulphur
139		250	Bicarbonate Soda
140	2		Bicarbonate Soda
141	4		Rubber Wax in Berdugo Canon 15 Humboldt
142	5		Rubber " " " "
143	3		Rubber X " " " "
144	6		Rubber X " " " "
145	8		Rubber X " " " "
146	1		Rubber X
147	2		Rubber
148	7		Rubber X
149	10		Rubber X
150	11		Rubber
151	4		Rubber X
152			
153			
154			

Jan 20¹⁹⁷⁷
 T.A. Edman
 J.A. Edman
 James H. Edman

DCE

[illegible]

. 236

No 13



June 20 1877

76 Ed

1 ✓	750	Di Carbonate of soda	
2 ✓	750	Di Carbonate of soda	
3 ✓	500	Di Carbonate of soda	
4	500	Iodine	
5	250	Valerianate zinc	
6	250	~~Valerianate zinc~~	Sulphur
7	750	Valerianate zinc	
8 ✓	750	Sulphur	
9	250	Sulphate Barytes	
10	500	Sulphate Barytes	
11	1	Sulphate Phosph	
12	250	Fine Chlor	
13	500	Fine Chlor	
14 ✓	500	Fine Chlor	
15	750	Sulphate Barytes	
16 ✓	500	do do	
17 ✓	250	do do	
18 ✓	2	Fine Chlor	
19 ✓	750	Tripoli "1"	
20 ✓	500	Tripoli "2"	

Noted
James Adams

*all these in 4 gms
phosphorus*

246

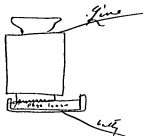
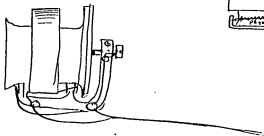


June 21 1877
 J. A. Edison
 Charles Batchelor
 James Adams

Made an Electric pen with a wheel instead of a
 needle today to cut tin foil on glass - Made
 a pen with 5 needles for ruling music =

Spending Telegraph

got Aug 3-2-1877



²⁵¹ Speaking Telegraph June 24 1897
 Edison
 Chas Batschelet
 James Adams

152 $\frac{1}{2}$ Plumbago $\frac{1}{2}$ Per Oxide Manganese
 153 $\frac{2}{3}$ Plumbago $\frac{1}{3}$ Bronze Powder.
 154 Pure Plumbago 4 per lb
 155 Black oxide copper—
 156 Plumbago & Graphite Carbon Magnesia & Graphite
 157 Plumbago 4 " Amalgam 4 "
 158 " 4 " fit made of Per oxide Lead Body Plum

Speaking telegraph

June 24 1877

Charles F. Telcelor

No

153

$\frac{2}{3}$ Plumbago $\frac{1}{3}$ Bronze powder
This is not good the articulation
is 110

152 $\frac{1}{2}$ Plumbago $\frac{1}{2}$ Peroxide Manganese
This is pretty good articulation
about 125 but not very constant

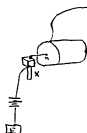
154 Solid piece Battery Carbon turned
up in lathe
Articulation fair and louder
than usual
but rattles exceedingly & buckles

155 Piece of wrought iron turned by file
exceedingly loud 126
had not the 126 articulation.
last one 126 notices in
we B.

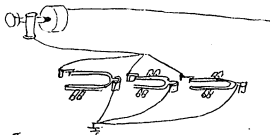
146

Speaking Telegraph

June 24 1877

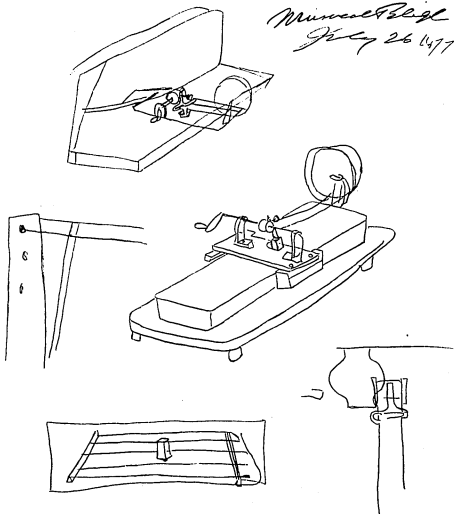
J. A. Adams
James Adams

vibrating & talking by the effects of
galvanism. If X is an aluminum plate
in which is laid a thin wire containing a
resistor subject to mechanical pressure
the vibration of X acting upon the metal
will cause vibrations of sufficient strength to
give over the circuit by means of polygraph
depolarization.



They form a series over the ground, proper vibration
of polygraph & the galvanic & telegraphic saving
only to the nation & clearness the
strength of the current to give
absolute

Musical Bell
July 26 1877



Speaking Telegraph

June 24 1877

Edison
Chas Batchelor

James Adams

W 53

15 Plumbago 1 Soapstone

Very bad about 95

42

4 Plumbago 2 Borate Baryta

No good at all could get nothing
but sparks

59

4 Plumbago $\frac{250}{No}$ Phos Iron -Articulation good 128 good
Fit clean

23

4 Plumbago $\frac{1500}{No}$ Bi sulphuret TinNo good at all could get nothing
Fit cleanThese experiments
are unreliable

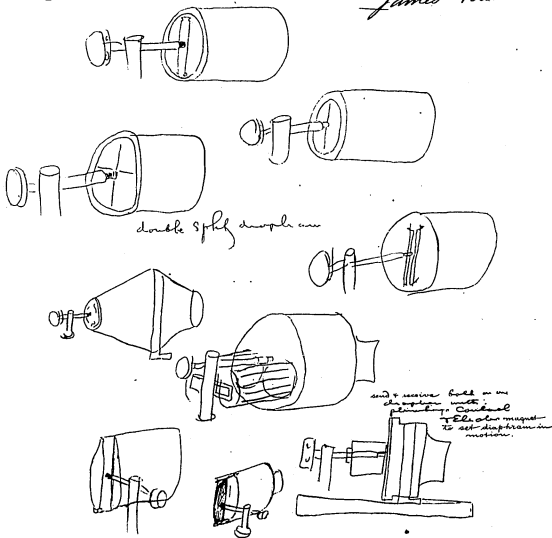
177

Speaking Telephone

June 24 1877

J A Edison

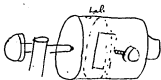
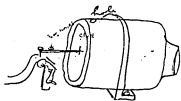
Charles F. Johnson
James Adams



247

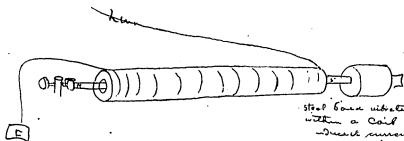
Spky Elograph

June 24 1877
 12 Edison
Chas. B. DeMott
 James Adams

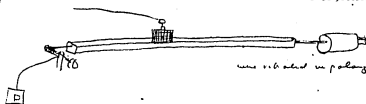


Spky through - a left

I propose to use
 an iron point pointed
 also a point of pure
 gas return Carbon
 also compressed Spring
 or other suitable powder
 with various material
 also propose to vibration
 a point inserted in a
 protecting solution
 insulated - covered
 External End -



*Steel core vibrated
 within a coil of
 direct currents.*



wire vibrated in polarizing liquid

243
Spky Telegraph

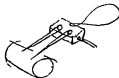
June 24 1877
Jas. Smith
Charles Batchelor
James Adams

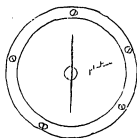
X-ray

There are 9 have found that
contacts at high speeds offer a
resistance in proportion to the
pressure I propose to attach a
small plunger & wheel in
front of a dynamo with great
speed by an electric engine or
other motor and plunger the
dynamo when the lever
you take the advantage of
pressure & you get advantage,



a 1/2 might be used





50¢ each

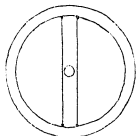
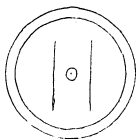
Diagram for piston

June 24 1894

J. A. Allen

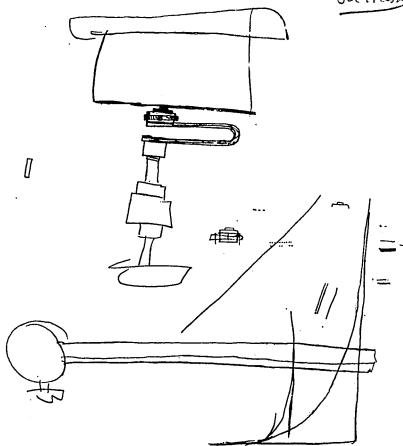
Charles Batchelor

James Adams



273
Telegraph

June 25- 1877
Ja Edison

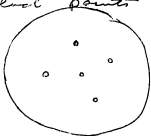


256

Spleg Tzlyh

June 25-1897
JAE

Diaphragms probably vibrate in
pat & have nodes I am going to
try experiment of several flexible
contact points on a diaphragm



James Holmes

Chas. Satchels

I find that although plumbago &
the Conducting Oxide & other compounds
which conduct are good & found
lead & other metals & melaloids
with or without surface make good
Contact will act to give vibration
of small strength & also the
Solid amalgam

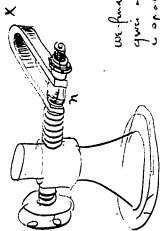
- 68 4 Plumbago $\frac{250}{\text{NG}}$ Bisulphur $\frac{25}{\text{TM}}$ 77
 Articulation 129 in buckling. Eddy
 Tit a little roughed
- 39 4 Plumbago $\frac{150}{\text{NG}}$ Iodine
 Articulation 125 no buckling Adams
 Tit clean
- 54 15 Plumbago 8 Carb Magnesia
 Could not get enough sound to
 pass an opinion on
- 10 4 Plumbago $\frac{250}{\text{NG}}$ Sulfate Borate
 11 Articulation 125 — no newspaper
 talk. Tit clean
- 53 15 Plumbago 1 Soapstone —
 Articulation 120
 Could not get reading


Spoken | 1000
188

188 25 188

1877

Edison
Charles A. Edison
James Edison



Edison Exhibit 184-11
L.L.G.

We find X sets like a tuning fork
gives after vibration when a word
is spoken also its own tone after
a word is spoken & during the
space of a word the table in it is
vibrated & present by

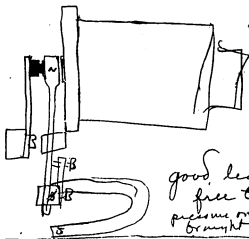
We find mended some kind oxide of Copper but
producing a conduct

207

Spkg Telegraph =

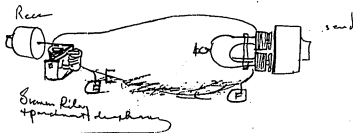
June, 25, 1877

J. A. Edison
Charles Batchelor
James Adams



good, leave diaphragm
free to move the
pressure on plumbago being
brought about by magnetism

Input on Bell Polyphosphate



926

No 54 4 Plumbago 1 Phosphate of Iron 77
 Articulation good but could get ^{something} drifting
 when reading from a paper. 125 Jas Adams

Note Hereafter we are going to test all for
 articulation by reading an article from
 Easy paper and if after the article is
 finished we get the sense of it we shall
 know how good our articulation is

55 15 Plumbago 3 Carb Magnesia
 Articulation 125 No Buckles
 Fits clean

150 15 Plumbago. 11 Rubber
 Articulation 129 No buckling
 Constant. Td clean

143 15 Plumbago 2 Rubber
 Articulation 129 good excellent
 Could not get all Td clean

Speaking Telegraph

June 25th 1877Test of Compositions continued.

Chas. Batchelor

No -

James Adams

234 Plumbago. $\frac{500}{H.C.}$ Disulphuric Tin -

Articulation good $129\frac{1}{2}$ very scratchy but
 excellent for all that. To clear
 with the poles changed got the articulation
 low but a little better, and not scratchy

When starting these experiments today
 we replaced the receiver with the wooden
 sounding box one.

We now put on transmitter a springy
 holder like this for composition



40

4 Plumbago $\frac{500}{H.C.}$ Iodine
 very good indeed Articulation $129\frac{1}{2}$

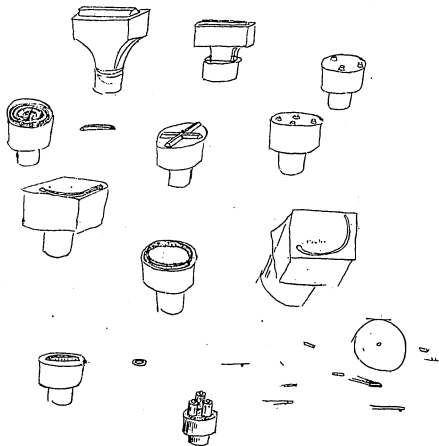
24 Retrying this with new spring we find
 it increased to 130 due either to
 spring or getting rid of bugs in wire

244
Spk 1 Elph

June 26 1899
J A Johnson

we propose to make moulds to
with the following shape for specimens

James Adams



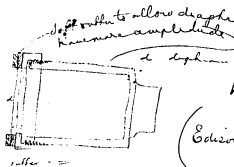
Speaking Telephone

June 26 1877

J. A. Edison

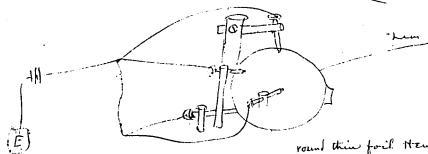
Charles F. Smith

James H. Adams

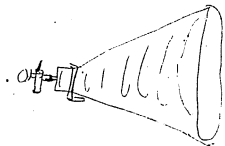


Edison Exhibit 191-11

S. L. G.



round thin foil Humbly tension
with plumbago paint at vacuum
point =



this funnel open to transmit
the air waves

Speaking Telegraph

June 26 1877
J.A. Edison

Charles Adams

We are going to build Peroxide of Lead
as Peroxide is used on the end of a plumbing
stick = mixture of a lead & zinc
or alloy with plumbing =

Things to be tried =

James Adams,

Platinum chloride

Gold pins

with the points protruding

Blacksmith's dissolved mercury

Lead & Conducting Salt and

fixed chloride of lead

with the pins used with various Conducting

substances =

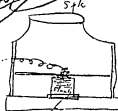
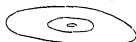
Speaking Telegraph

June 27 1877

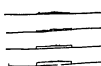
J. B. Edison

2 find that weighting the center of the diaphragm gives better articulation
therefore Batchelor is making 4 diaphragms

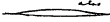
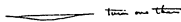
Batchelor



of the same brass & weighting the center by soldering different thicknesses of brass



also



also the

Speaking telegraph.

June 27. 1877

J. A. Adams

Charles Adams

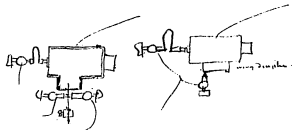
James Adams



See in letter to
postmaster weights in
to weight heavy clasp

The leaf X is adjusted to respond to
the heavy currents which are placed

Connections may be made in various ways



It is from another sketch shown to
demonstrate the telegraph mechanism
the working mechanism of
"flashing hammer",



This is a small (old) paper and
weights of which are placed
to the heavy currents

Edison's Exhibit 196-11
229.

Speaking Telegraph

June 27, 1874

Edison

Chas B. Tschelar

James Adams

We now made 4 Diaphragms of 52 Jewellers
brass each being weighted but all different
weights thus



A. Diaphragm
B. Weight $\frac{3}{4}$ diameter
C. Piston

No 1 Weighted with No 52 Brass

2	"	"	38	"
3	"	"	20	"
4	"	"	No 16	"

We first put in the thickest diaphragm

4
No 66 11 Plumbago & $\frac{250}{100}$ Lycopodium

Speaking Telegraph

June 27. 1877

Edison

Chas B. Decker

James Adams

We now made 4 Diaphragms. of 52 Jewellers
brass each being weighted but all different
weights thus



A. Diaphragm
B. Weight $\frac{1}{4}$ diameter
C. Platina

No 1 Weighted with No 52 Brass

2 " " " 38 "

3 " " " 20 "

4 " " " No 16 "

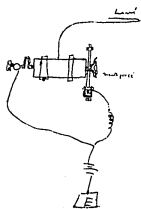
We first put in the thickest diaphragm

No 66 11 Plumbago & $\frac{250}{100}$ Lycopodium

274
Alfred Kellogg

June 27 1877

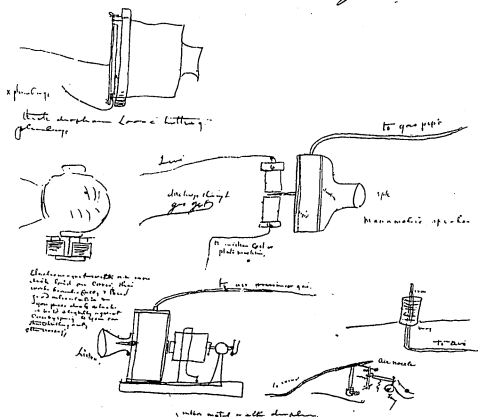
Col. James Adams
Quincy, Mass.



*Having commenced in
 June & regular vibration
 talker.*

27.
Edison's Telegraph

June 21 1877
J.A. Adams
Chas. H. Adams
James Adams



Electricity is sent down the wire
which leads from the battery
to the lamp. The lamp is a
small globe of glass & metal
which is heated by the current
passing through it. The lamp
glows when the current is on
and is extinguished when it is off.

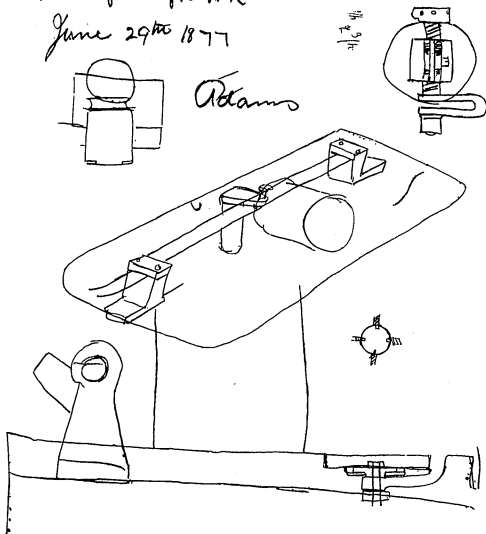
Win. H. Adams

The Lamp may replace the Magnet

272
Speaking telegraph

June 29th 1877

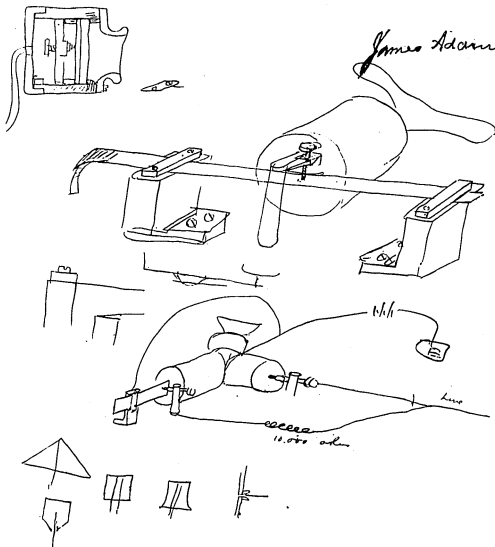
Adams



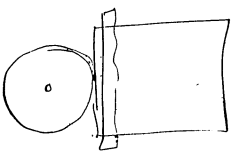
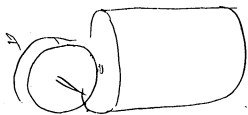
Speaking Telegraph

June 29 1877
J Adams

James Adams



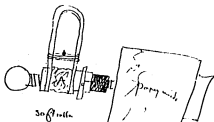
James Adams



11/23.50. 1877. July 3^d 1877
H² Delm

EDISON'S EXHIBIT. 2-12.

Spoke & Wheel

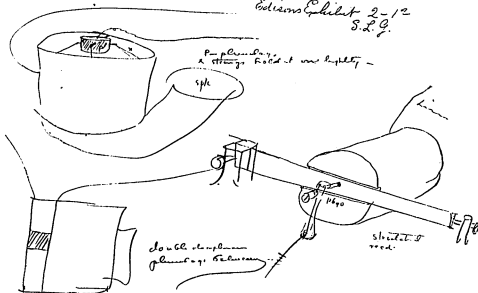


July 5 '87

*Edison
Charles Batchelor
James Adams*

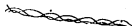
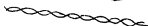
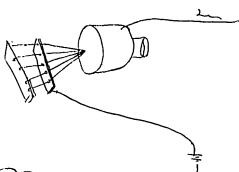
Diagram to prevent vibration, rubber under spring to prevent vibration
to prevent all vibration between a sh & a B

Edison Exhibit 2-12
S.L.G.



202

Bpdy / 202



July 7 1897

Taken

Chas Barchelor

James Adams



Speaking Telephone

July 7 1877

J. A. Brown

Chas. A. D. L. L.

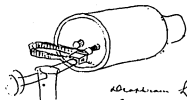
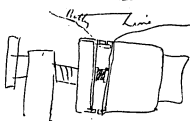


Diagram shows in center a contact point placed over on side the also at being to get rid of the machine. In the diagram when striking the contact point is placed in center, this is some rebound when when placed in the middle but the weight - Center - is diagram prevents it.



Edison's Exhibit 6-12
S. L. G.

Plumbago fastened to the diagram by the end =



253

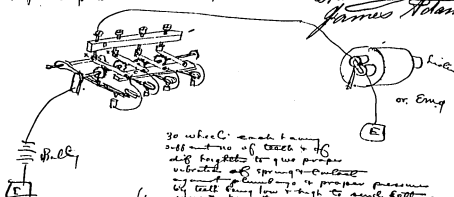
Speaking Telegraph

July 11 1877

J.A. Brown

Chas. A. Brown
James Adams

A x plumbago B vacuum C dial,



30 wh. C. small lamp
diffusion of light & H
diff. bright to give proper
vibrations of spring & contact
against plumbago & proper pressure
by talk being low & high to send better over
wire & how it reports distance = exactly variable
distance may be sent by variable
disposition of vacuum C dial

X diaphragm



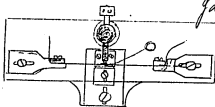
I propose to utilize the gas pipe system
in factories houses etc. to convey
the human voice & allow of communication
being carried on also from any one point
of the gas system to the other & vice versa
to great advantage in different parts
of a city especially applicable to
fire alarm telegraph & I accomplish it

by having an extra orifice fitted to the gas pipe similar to
that made by disconnecting a burner from the pipe - in other
words attach an extra tube of iron or a flexible
tube the other end of which is attached to the material
fit of a tube the other end of which has a diaphragm.

255.
Talking tele

July 14th 1877
Edison

Chas Batchelor
James Adams



Porcelain
insulators

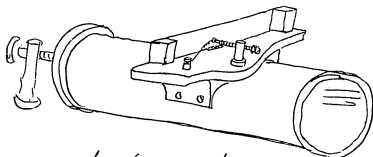
open

Boston
N

297
Sprocket Telegraph

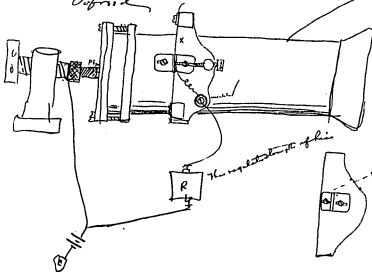
July 16 1877
J. A. Baird

Device for transmitting the hearing connection. The hearing
parts of speech
Charles Paley
James Adams



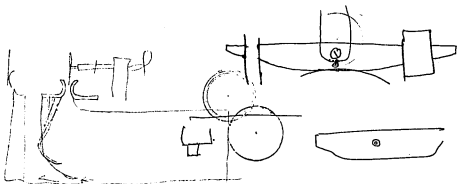
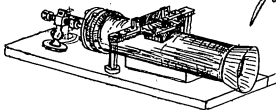
May be necessary to dispense
with the regular plating point
resistor, a spring plating
point, as it is not to check vibration
differs

The leaf or reed
fastened at both
ends, with a spring
it is made stiff
stiffness makes me
believe over the
slab =



The first design
of this was made
of brass and
of the same
leaf with the
the hearing
sound. But
very faint, when
built. Had good
distinction only
it =

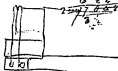
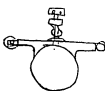
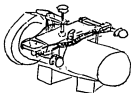
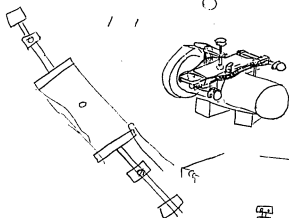
July 16 1877
Zachary
Chapman
James Adams



287 Sperry T. S. L.

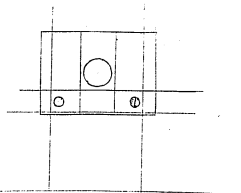
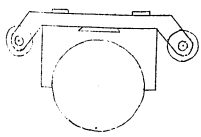
July 16 1877

J. A. Edison
Charles F. Smith
 James Adams



S. 62.

6 76
 16 744
 164
 6 828
 164
 164

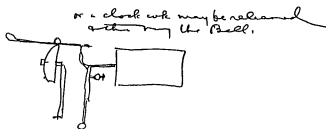
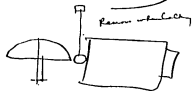


255
 Geo. Peppel Esq.

July 16 1877

7a Edison
 Chas. Batekator

I propose to ring named Bell by the vibration of
 the diaphragm sitting in pendulous vibration a
 Wicksop & ball to strike a Bell or the vibration
 of Tipton may release a bell-strike or a
 changing Gas jet may be set in motion by
 the vibration of the gas or the diaphragm
 may control a valve opening & release (in the
 case of vibrating) gas which acting on a sensitive
 whistle call attention



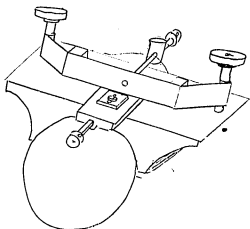
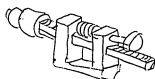
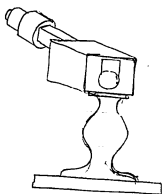
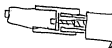
²⁴⁶
Opening Telegraph

July 16 1877.

J. A. Edison

Chas. Batchelor

Wm. Adams



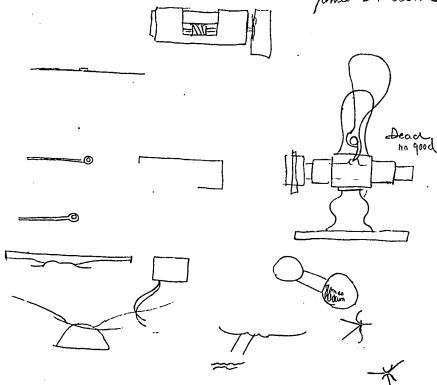
EDISON'S EXHIBIT, 15-12.

271
Speaking telegraph

July 17th 1877

Edison

Charles A. Smith
for Mr. Adams



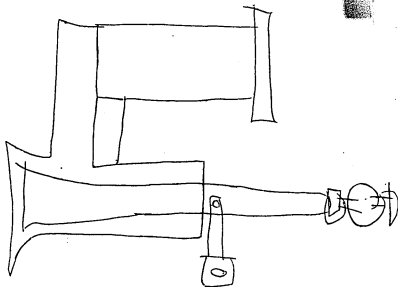
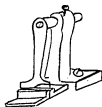
EDISON'S EXHIBIT. 18-12.

Opdy B. S.
244

July 17/1847

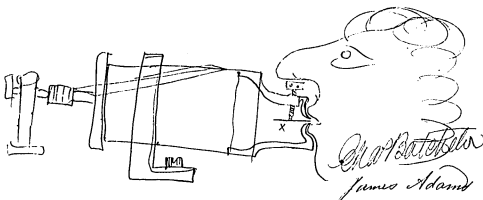
To Edison

Chas. H. Pritchard
James. Adams



2.
Speaking Telegraph

July 17 1877.



X Mica or Rubber Feed for the Micaing (magnifying)...

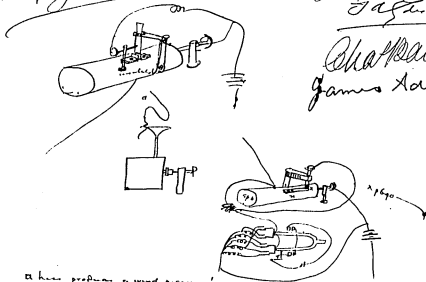
~~Notes - Chalk Balls are soaked in a Concentrated
Alcoholic Solution of Ammonia or other
Calor and dried & packed with Dextrose or other
Substance to keep them from becoming hard
thus an enclosure will be given for transport
by Mail. for use in any place as of the
Balls in a Bottle containing water shake and
ready for use. - Perhaps fragments of glass
from wood to fill the Chalk.~~

Spleg Beugrüb

July 18 1877

Talpa

Chas. B. Ketchum
James Adams



It has produced a sound pressure in
the tube and it will move a line
pressure against the plunger point
X the then in a his sound produced
by a tuning fork arranged to give an
number of Contact 1 after the other.

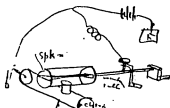
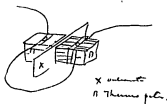
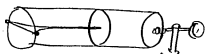
Send May 6/97

EDISON'S EXHIBIT. 25-12.

502

Sply 1 Diagram

July 15 1897
Massachusetts
James Adams



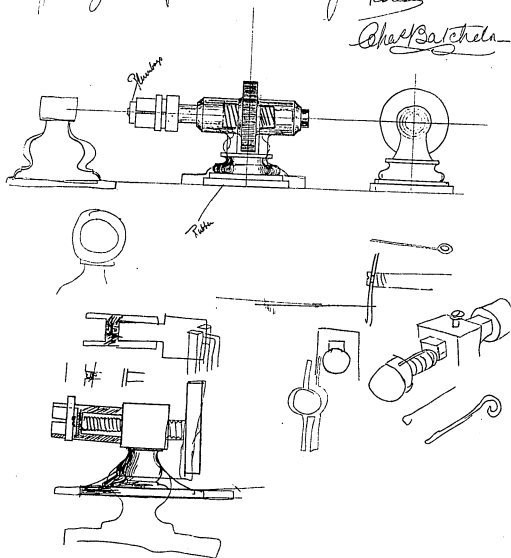
The whole device
is heavy but
stays still. The regular
vibrations are on
down the

X is a roller mechanism connected to the
Control diaphragm and the edges
being near or between the lips in
the act of sphy it gets a vibration
which is communicated to the Control
diaphragm & then to the
set the entire diaphragm in
vibration hence the hearing
Circuit as reinforced &
used to set the diaphragm
in motion we just tried
an experiment similar to
the one

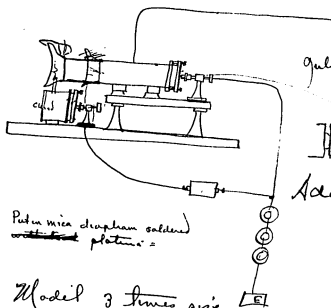
Just tried experiment with a diaphragm
having an embossing point & held against
paraffin paper moving rapidly the
sphy vibration are evident & novel
& thus we doubt that I shall be able to
pick up a reproduction automatically of any
other than the human voice probably

Speaking Telegraph

July 18th 1877
Chas. B. Bache



306



July 20 1877,
T. A. Edison
Edison

Adams

Put in mica diaphragm soldered
~~with~~ platinum =

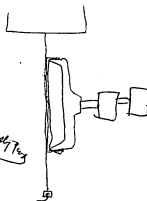
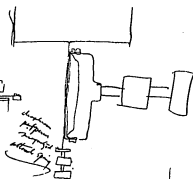
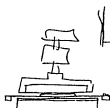
Model 3 times as big
draw

\$1000.00
1/11.00

294
Speaking telegraph

July 25th 1877

Edison
Chas. Batchelor
Adams



then - pull it

310



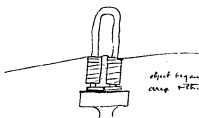
July 20th
1877

Adams

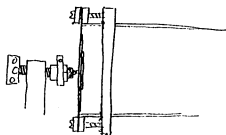
27-
A. S. P. K. K. K.

July 20 1891

Chas. K. K. K.
James Adams



split beyond into distributed power magnetic puller and
are either of the form of the diagram



a diaphragm to this is secured a smaller diaphragm & the
again is secured a smaller piece the object
being to stiffen the diaphragm in the center &
still leave it free to move, by raising rather
power of light substance the diaphragm is
not necessarily loaded

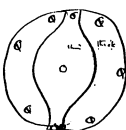
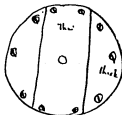
Spkg. Ktograph

Diagram

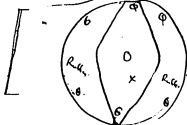
July 20 1877

7th Edition

Chas. Batchelor



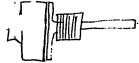
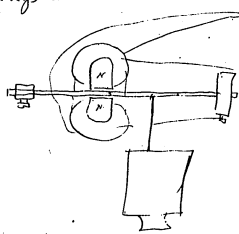
(Edison's Exhibit 37-12)
L.C.



James Adams

clear across the diaphragm X.

put rubber at other ~~of~~ ~~between~~ ~~or~~ rings between the diaphragm on the rings -



312
Benny Blyth

July 20 1877
T A Edison

Christa E. Adams

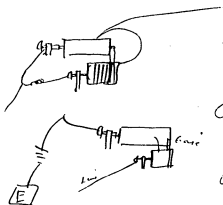
- Inhibiteurs de GABA et des récepteurs de l'acétylcholine

[illegible]

Bones:
 Py. of bones & Pelvis
 Trachea
 Ovarium
 ut. bladders & paps.
 Winc. glands. Guts & ... in ... paper.
 Pen. chinit.
 Pen. chinit. paper.
 Black note from Guts
 Pappus graph. paper.
 Pencil bladders & acid,
 Raw hide
 Bilets.
 Papyrus
 Tracheal bladder
 Pelletum.
 Phosphor bronze
 Aluminium bronze
 Russian Lanth
 White spruce shabla's
 oil cloth

by Tilgh =

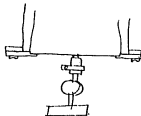
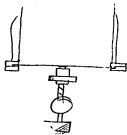
fixed the other



July 21 1877

Adams

are putting in a very thin mica
diaphragm placed between
2 rubber rings & brass rings =
going to try a loose diaphragm
between rings = also a
diaphragm in tube & finally
for & play of with it & play
permanently in place & go =
taking in the well cause outer
edges to vibrate but the
center will not vibrate but
give passage for sound



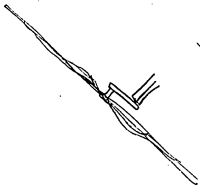
323

~~Spring T. B. L. S.~~

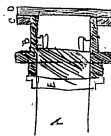
July 23 1877
Edison

Chas. B. L. S.

James Adams



Pluses Make an end for latter then
we want a diaphragm $\frac{1}{8}$ inch larger than you want
put an end on the old tube -



A old tube
B new attachment $\frac{1}{8}$ larger
C + D diaphragm ring
E old screw

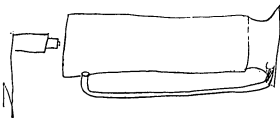
Don't increase length any more than
you can help And do not take old instrument
apart till you have the other ready to go in
The screw B must be secured to the old tube with
set screws

Datcher -

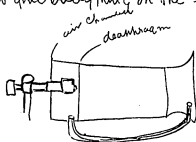
July 23 1899

325
talking telegraph

July 23^d 1877
Edison
Adams
Chas. B. Bletcher



intended to give everything on the same diaphragm



318 talking telegraph

July 26th 1877Length Rubber $\frac{1}{2}$ inch Adams
Weight as Tit.

Plumage 15 Parts with 3 gram weight-

Rubber 1 "

Res - $\frac{1510}{2440}$ ohms

" 4 gram

" $\frac{1240}{1240}$ "~~Weight~~ Length Rubber body $\frac{1}{4}$ inch.

Resonance with Contact disk weighing 3 gram = 12400

2-1st 1460

3-2nd 1510

4-3rd 1680

5-4th 1910

7-5th 1410

8 " 1480

on this first jump about goes from 73°
to 9 deg

now with 1 gram extra

 $\frac{710850}{1538}$

1538

1538

1st, - 1480

no oscillating
on a Tit

³³¹
Epigraph

July 26 1897

TA Edison

Test of Resistance of Thumbago

James Adams

Flat Thumbago no Tit = flat. 3 gram contact point.

1000 ohm constant in (current) = included - by Resistance. 1,140
with 10 grams added 1080.

now take 10 gram off with no change



Speaking Telephone

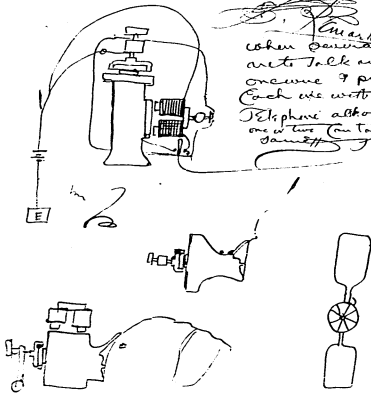
July 26 1877

১৯ (৫৯৯)

Gyrfathur

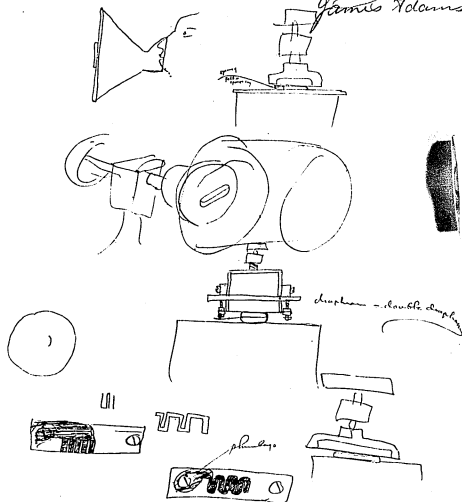
James J. Davis

when several persons
wrote talk over
once we provide
Each one with a
Tel. phone although
one or two can talk with
same Table



323
Speaking Telegraph

July 26 1877.
E.A. ~~Edison~~
Charles Batchelor
James Adams



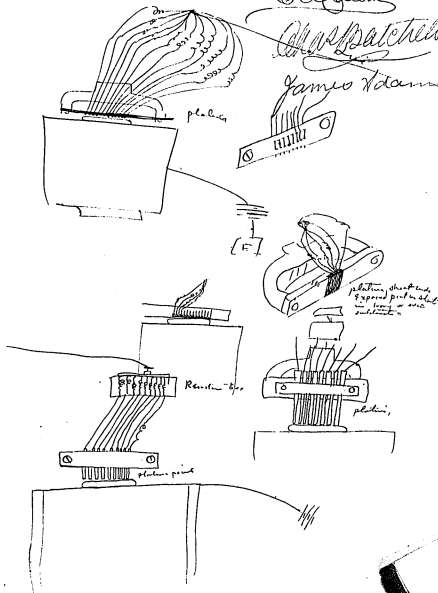
²²⁵
Speaking Telegraph

July 26 1877

Edison

Chas. Batchelor

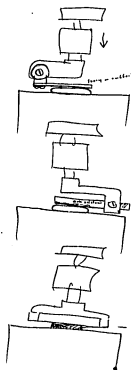
James Adams



346
Speaking Telegraph July 26 1877
T. Edison

or that the plumbago may be put on
 any surface such as a surface of rubber
 hard or soft which would

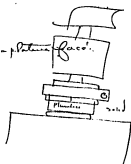
Charles Batchelor
 James Adams



Arkansas oil stone or other
 hard substance contact with
 plumbago etc.



light-plum plating

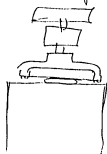


Speaking Telephone

July 26, 1877.

Edison

To obtain a very delicate Telephone I make the
 Diaphragm of mica place a very delicate
 Bow Spring upon it and coat
 a Rubber strip with Plumbago
 James Adams

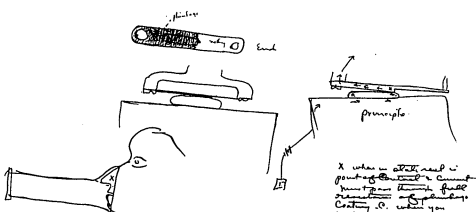
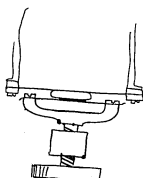


Instead of Coating this strip with
 Plumbago it may be coated with
 any inferior Conducting substance
 such as finely divided silver or other
 Metal sometimes used by Electrotypers
 to Coat their non Conducting surface
 It is not necessary that the Reed
 should be made as shown I find
 that it may be free at one end
 that it may be of any flexible substance

337
Speaking Telegraph

July 26 1877.

Edison
Charles Batchelor
James Adams



X is a nose piece serving to
confirm & render operation
upon the diagram the
vibration from the nose (10)
The nose (10) which is
the nose piece of the telegraph
which is necessary for perfect articulation

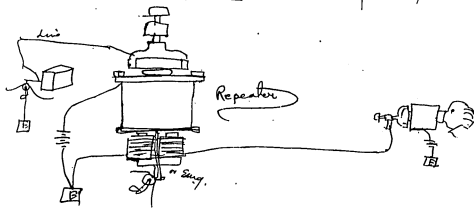
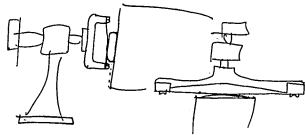
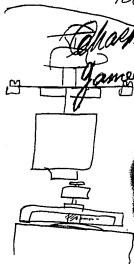
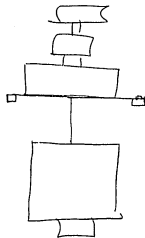
X when in contact with
point of contact & contact
point from which field
current is produced.
Contact O. when you
touch the spring R under
more contact of the contact
does not give current
as much as when
which has the other
position of the
The human form of

Spoke Right

July 26 1877

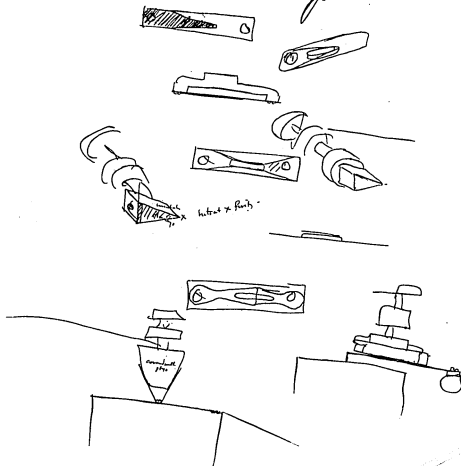
701 Edison

Charles F. Smith
James Adams



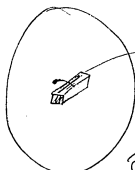
Speaking Telegraph

July 26 1877.
J. A. Edison
Chas. K. Stein
James H. Williams



342

No 45



felt

25 C

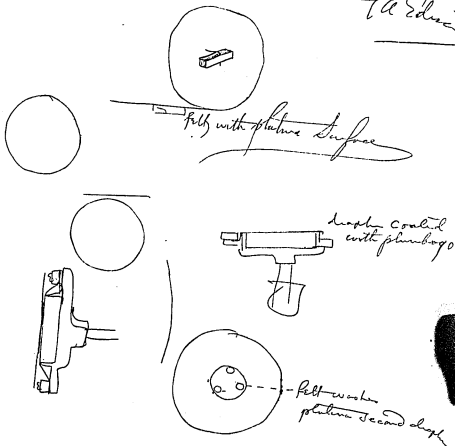
Adams

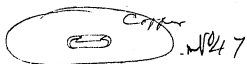
Delivered July 27/1899

243

Opoly Telegraph

July 27 1877
T A Edison





50c

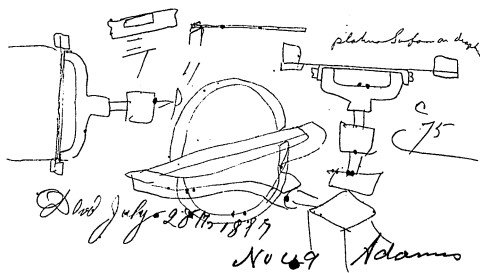


Splg Tiltg

brass shield

Del'd July 28th 1889 Edison

EDISON'S EXHIBIT. 70-12.

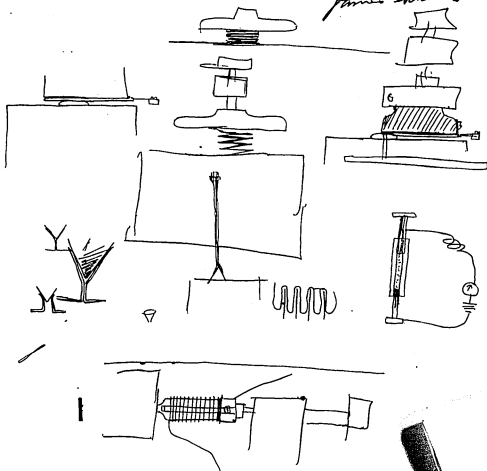


EDISON'S EXHIBIT. 72-12.

Speaking of Chapman

July 28 1877.

J.A. Baird
Edgar A. Batchelor
James Adams



EDISON'S EXHIBIT. 73-12.

No 48

30 cents



Spky Telgh

Depd. July 28th 1877

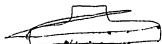
Adams

*

4/5 Cent



Spky Telgr



Adams.

Del'd. July 28th 1874

100

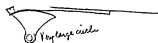
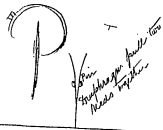
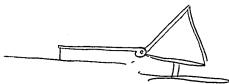
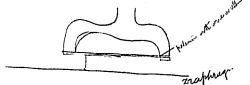
Speaking Telegraph

July 29th 1877.

Edison

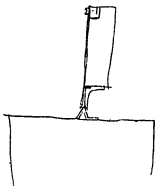
Charvatichler

James Adams



EDISON'S EXHIBIT, 77-12.

¹⁰⁰
Ephraim Gilg



July 29 1877
J. D. Edison
Charles B. Ketchum
James Adams

EDISON'S EXHIBIT. 78-12.

49

80pkgs July 29
Ely
Chapman
Stam

Chapatchela
Adams

STUDY 1

L. Hunt

Arthur

[Handwritten signature]

Island Portland

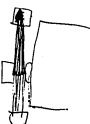
André

Geo. P. Lawrence

[Handwritten signature]

W. H. Allen

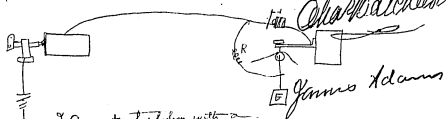
Verigues



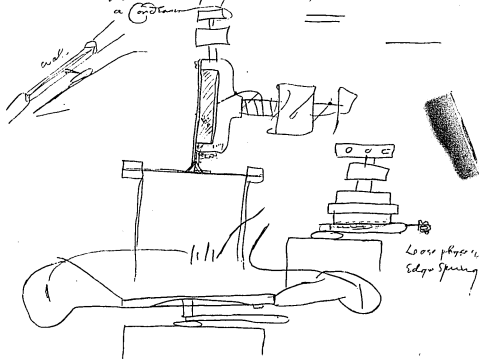
386

Chas. H. Pugh

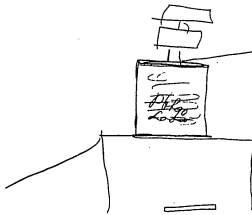
July 29 1899



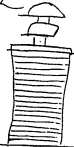
I can get articulation with a
 gelatin joint strain with a
 getting in a Relay at the display
 station & hunting around it as
 as to fail the vibrations also can
 do same thing by shorting the reverse with
 a condenser



³¹²
Spending Time July 29 1897
Edison



John
Trapan
Adams



Rubber Cones
Thick Cones
taken Aug 1890



When a rubber
sheet plays over any





No 46

July 27 English transmitter \$10.00
10.00

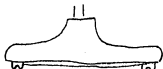
July 28. 2 Spring Lenthogram

No 47



50¢

July 28th



No 48

30¢

Plumbago Paper holder
July 28



No 49

75¢

July 28



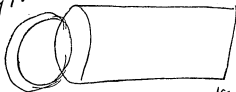
No 50

75¢

July 26	Leak	1 hour
" "	" English recovered	6 "
29	" "	6
30	" "	13
31	" "	15
		<u>41</u>

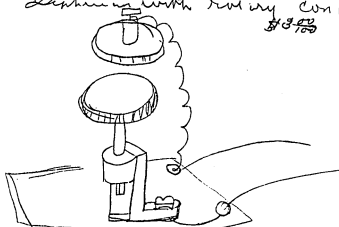
Aug 1 st	Returned for England	17 hours
2	" "	2
2	" " " " " "	<u>19</u>
	" " " " " "	8
3	" " " " " "	13
4	" " " " " "	10
5	" " " " " "	8
6	" " " " " "	10
7	" " " " " "	<u>18</u>
		<u>67</u>
8	" " " " " "	7
"	" " " " " "	1
9	Using Blow off the magnetic telegraph	20
10	" " " " " "	5
11	" " " " " "	10
12	" " " " " "	9
13	" " " " " "	10
14	" " " " " "	10
"	Shifting Machinery	<u>3</u>
		<u>75</u>
15	Magnetic telegraph	14
16	" " " " " "	14
17	" " " " " "	14
18	" " " " " "	10
19	" " " " " "	19
20	" " " " " "	4
"	Sawing Machine	1
21	" " " " " "	13
2	Johns one Diaphanous	13
		<u>2</u>
		Experiments for Phy forms
		William & Glenn
		25¢
		91

July 1st



No 42

Experiment with driving Contact Point
~~8/3/83~~



July 1st Aluminum & Platina Plates Experiment
~~8/3/83~~

No 43

~~8/3/83~~

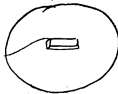
July 4	Plumbago cup & Mangle	8 hours
5	cleaning Good Stock	5 "
6	" "	13
7	" "	10
8	" "	10
9	" "	13
10	Repairing Engine in Shop	6 -
"	cleaning "	7
11	" "	13
		<u>90</u>

July 12 th	12 hours	15
13	13 "	4
14	8 "	
15	6 "	
16	13 "	
	<u>52</u>	

17	Speaking telegraph with S. H.	12 hours
18	Attachment	11
		<u>23 hours</u>
18	fixing E. H. Johnson transmitter	
No 44	# 3 <u>FD</u>	

July 19	Speaking telegraph with S. H. attachment	6 hours
"	~~8~~ hours	22
20	~~22~~ hours	6
21	Screw Drivers	4
"	Speaking telegraph	10
23	Dephragram	10
24	"	1
25	"	2
26	"	3
"	Patterns Engraved received	1
27	" " "	3
"	Johnson Dephragram	1
		<u>75</u>

No 427



Dephragram with felt under
Platina

25¢

No 45

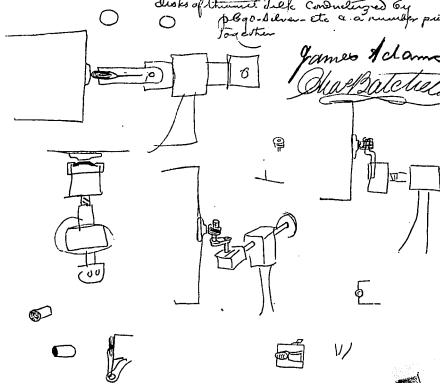
¹⁶
Spring 1897

Aug 1, 1897

Edison

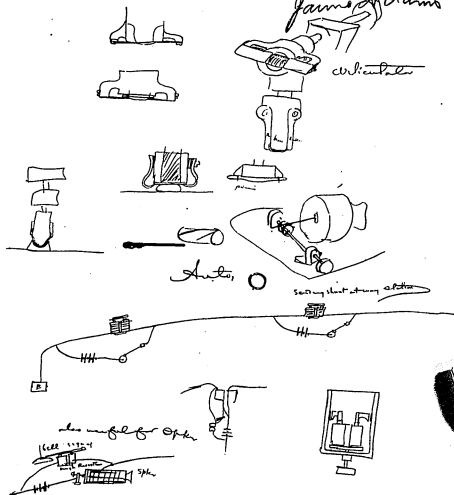
disks of thinnest disk conducting by
p. 60. Silver - etc. a number put
together

James A. Adams
Charles B. Adams



~~Working Copy~~

Aug 3rd
To Edison
Chattanooga
James Adams

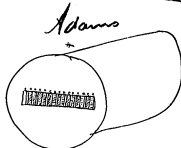


367 Speaking Telegraph

Charles F. Johnson
August 5, 1877
T. Edison

I find that sponge having its pores well filled with plumbago, finely divided smelt or conducting oxide or substance of good flat nets beautifully as an articulator. I have found that if the conducting substance be mixed with sand or other material which will prevent it from caking that good results can be had.

I find that if the bronze bit & the platens on the diaphragm are previously coated with some substance of the nature such as asphaltum, camellia or fine fibre with plumbago, or other semi-conductors used that we get two rough surfaces which when put together give very fine articulation.

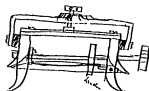
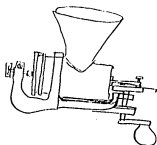
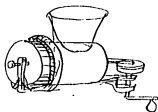


into agent mentioned above

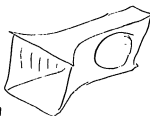
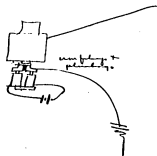
Edison's

Transmission de

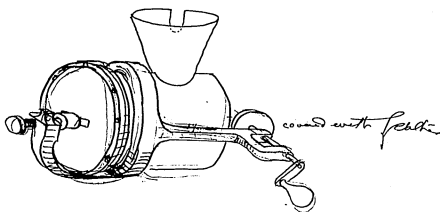
deux
dents



Aug 6 1877.
To Edison
Charles Batchelor
James Adams



266

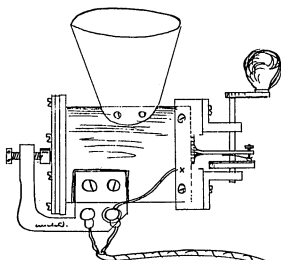


covered with leather

*Aug 6 1877 Pocket Speaking Telegraph Given
Bathur*

265

Adams



X end speaking - Rubber diaphragm

Portable Speaking Telegraph

Chapman

August 6, 1877
Edison

Frank B. Rowland

Aug 7 1877
Edison

I find that with the sensitive articulator that it is seldom you can put in a metallic diaphragm without ~~transmitting~~ the ringing sound of the vibrating metal (D) harmonics. Due to inequality in plate, but by using mica or other no ringing substance the effect is obviated. It is very important another ringing sound to accompany good lettering, or rather articulation. A diaphragm would be a source of trouble. I tried fat and leather to get rid of them. Of course the diaphragm did not get rid of them. I tried a piece of wood not quite a proper movement or have stiffness enough to it. Compress the inferior conducting material have to make a success such substance as wood - mica - vulcanite etc must I think be used although soft metal like gold & platinum might be used.

Chas. Matichels
James H. Lewis

Speaking Telephone

July 7 1877

Chas. B. S. S. S.

T. A. Edison

I find that this machine will if cut up in short lengths
 say 1/2 inch or there will plumbagoed will after passing
 carefully retain the plumbago in spite of the
 vibration of the diaphragm here as the maker
 a very good articulator = I find that to get
 the heavy sound of speech good &
 strong it necessary to use the slot in the
 Mouth piece even on the new "Speakers"
 the heavy sound striking the sharp edge
 of the slot somehow as cut into strong vibration
 & there set the diaphragm in vibration

James H. S. S.

37

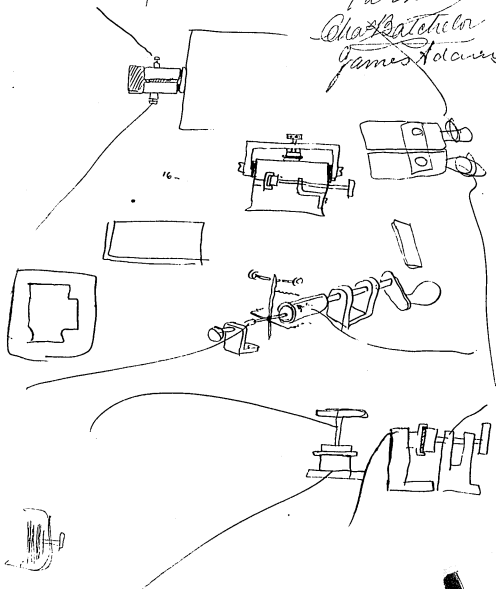
Spky Plug

Aug 7/77

7 a.m.

Chas. Batchelor

James Holmes



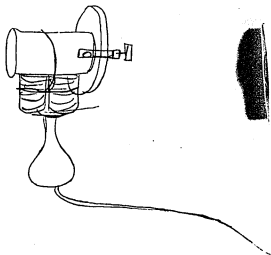
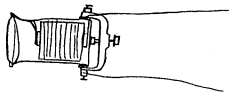
My Dear Mr. Adams

August 9 1877

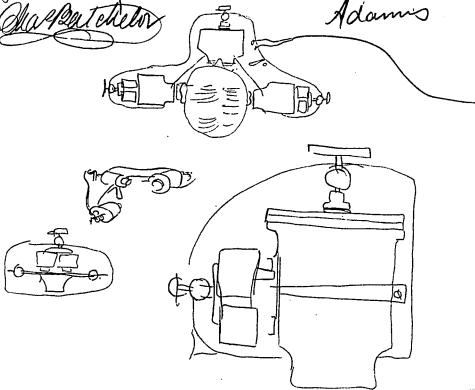
Wm. Adams
 Charles B. Adams
 James Adams



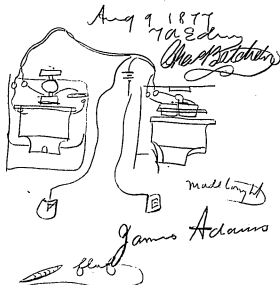
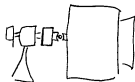
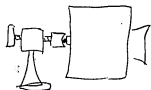
distinct box with key to call a person in
 box to tell who it is that is wanted
 also call bell in box & the code
 used to call person whose box is
 from Central Station



Spky 924h Aug 9 77
 diggled all day had 40 calland
 15 ohm sand magnet disten
 way was trans then back 69 miles -
 got ording conversation =
 Charles Patchen Adams



Sply Telegraph



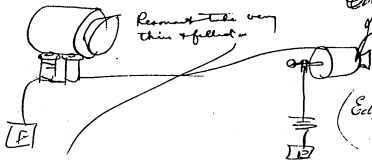
Take waxen rolls & pick it out so that fibre
will not lay straight & close the hole
sharp par scissors & cut it off in pairs about
1/8 inch long then plumbago it & roll it
up in cigar shaped rolls & place in the Transmitter
straight by hand after rolling with a long straight
fibre to hold it together well or moulded
like a cigar? ~~use~~ The magnetic ream
I use wood tube & thin diaphragm which
I prevent from ringing or aft. vibrat
by two deaden rubbers or equivalent
carefully press diaphragm inward or
outwards as case may be - tested
magnetic Ream to try & back & on length

Aug 12 1877.

J. A. Edison

Charles Batchelor

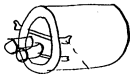
James Adams



Resonator the very thin & filled in

(Edison's Exhibit 105-12
L. G.)

Insert in filings or fine filings, or loose iron wire.



Soft rubber to decelerate the diaphragm at which will
prevent harmonics or excessive vibration
hard piece of rubber or equivalent
Could be placed in different part
of the diaphragm & shell as
they adjust to semi to dampen
it =



* is piece dry paper with iron filings, in it
fills with gas



angle piece

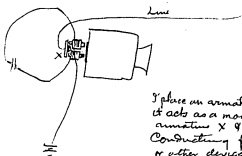
diaphragm
with center removed

* is thin paper going clear across
the diaphragm

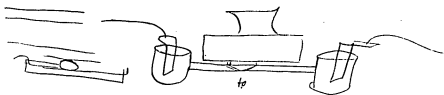
310 Speaking Telegraph

Aug 16 1877

J A Edison
Chas B. S. Keller
James Adams



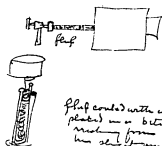
I place an armature on the diaphragm & it acts as a movable yoke in back the armature X & arranged with piece of conducting fibre loose ply. Water or other device for increasing & decreasing the resistance by a movement, and the movement of the yoke on the diaphragm causes the electric energy which is in a constant current to be converted weak as it approaches proceeds from the magnet this causes the armature X to vibrate and a not attracted & variable pressure movement then places in X



Edison 1 August

Aug 17 1877

Mr. Henry
Blackwelder
James Adams

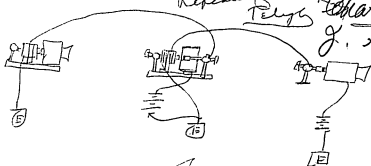


Plaf covered with a Semi-Concave or concave
placed in a bitumin 3 inches deep
under glass in a point diagram
has set of you as a covering glass
to its center (s) + 5 ft in dia
the movement - the old for frame.

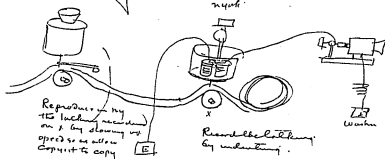
Edison's *Telegraph*

Aug 17 1877

Repeat for *Telegraph* *Edison*
W. H. Paine
J. H. Adams



Transmit by which we can carry
the communication any where in a
room



Reproduce by
the (hook) needed
on a long slowing up
speed so as to allow
copyist to copy

Receive by
inducting.

Experiments on Speaking Telegraph
Aug 21st 1877

Short Battery

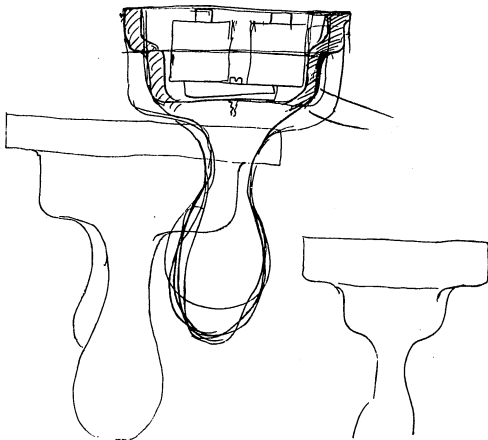
No 1	Fluff good can read at ~~2500~~ ohms	
	- good articulation with 2 instruments	
2	No good	
3	No good	
4	Fluff good articulation	- 300 ohms
5	- - - best	- 1800
6	- - -	- 2200
7	is more	
8	- - -	3000 ohms
9	- - -	1000
10	- - -	1200
11	- - -	6800

412

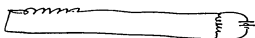
Speaking Telegraph

Aug 24th 1874

Chas B. S. Phelps
James Adams



311

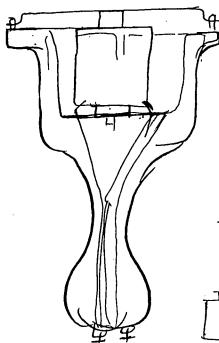


Aug 24 1877

79 Edison

Chas. B. Adams

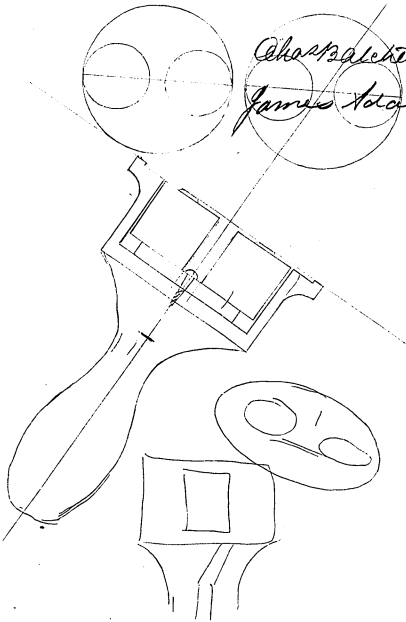
James Adams



95

Aug 24th 1877

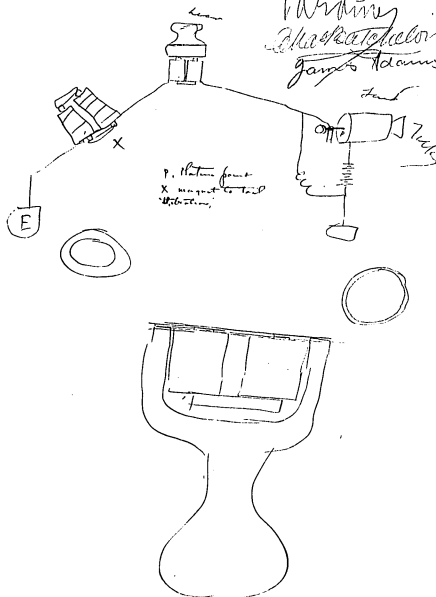
Chas. B. Alcock
James H. Adams



208
Edison's Exhibit

(August 25, 1877.

W. H. P. Hatcher
James Adams



405
Edison Telephone

Aug 25 - 1877

J. A. Edison

Chas. Batchelor

It is probable that I may be able to Condense
 Vapors of metals such as Hg & Tellurium in
 fibres thus making them Conducting.

Jamies Adams



I propose to have one receiving telephone or annunciator
 with a no. of cells & each cell is connected to
 a battery or feed out of 1 battery passing to
 several electric wires with
 sounding arrangement, this will repeat
 the sound many times & it -



Hinged box made of wood in which
 is telephone apparatus the top to be
 used in noisy places the head of
 the person talking is supported in which
 6 of -

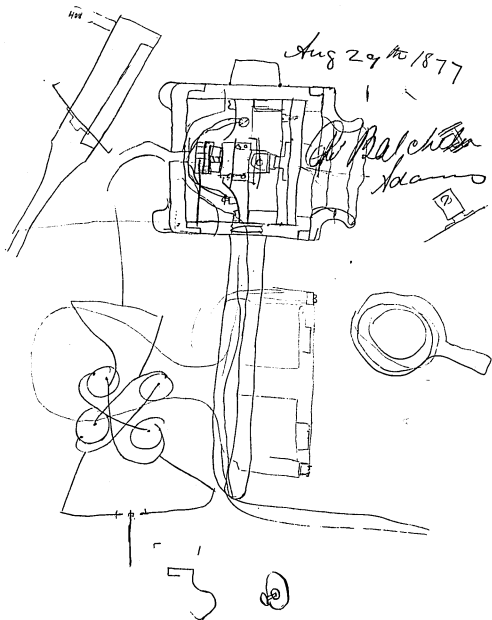
¹⁴⁰³
Sply Itograph



Small battery

Aug 25 - 1877
T. A. Edison
Chas. Batchelor
James Adams



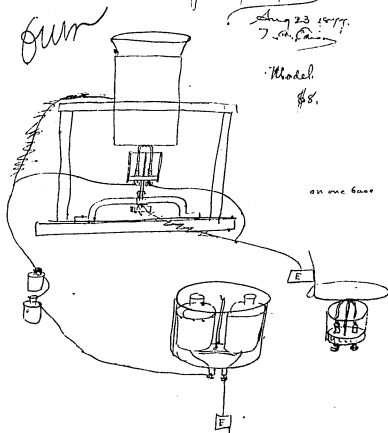


Del'd. August 30th 1878

Speaking Telegraph

Aug 23 1878.
7. m. P.M.

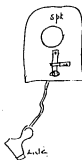
Model.
\$8.



Splnd Telephone

Domestic Tel

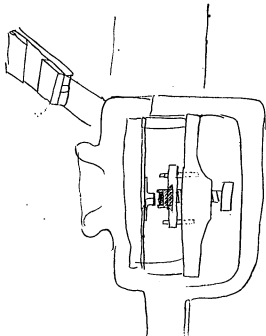
Aug 30 1877
T. Edison



signaling key

The telephone circuit James H. Adams
to fire boxes and signal
on police telegraph for
summing near engine etc
I propose to include it with the
same circuit with the fire
signalling apparatus that
city the plug & receiving
magnet only when talking.

Chas. B. Hatch



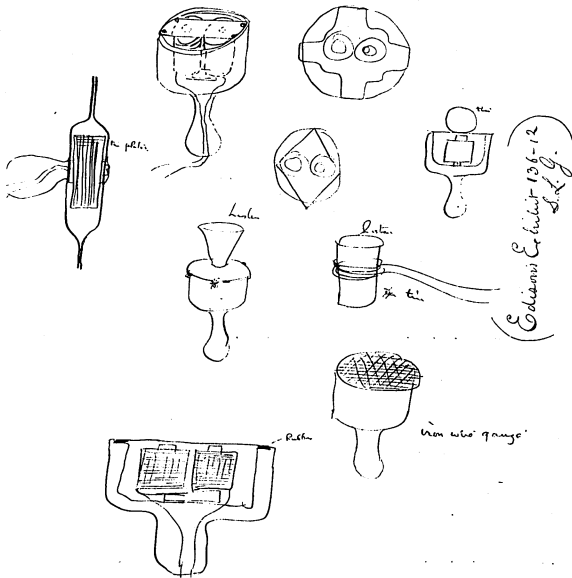
new spln

the
Speaking Diagram

Receiving instruments

Aug 30 1877

Tolson
Charles D. Cheney
James Adams



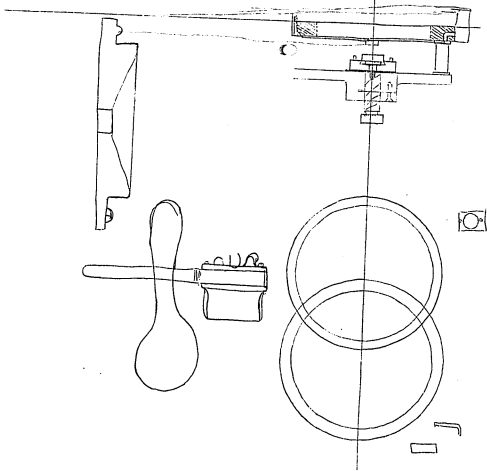
Spky Bligh

Aug 30 1877

79 Edison

Chas. Ketchum

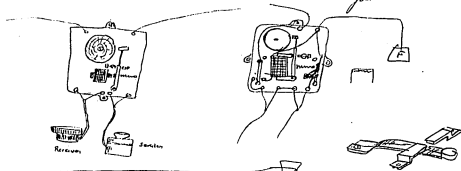
James Adams



Speaking Telegraph
C. P. Boff.

September 4, 1897.

J. G. Edison
Shackleton
James Watson

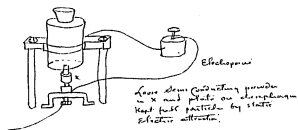


I find that the silk if properly reduced by phosphoric acid is a fair conductor with the proper amount of Nitric acid & well reduced is as good if not better than phosphoric acid then will make Speaking Telegraph Circuit, need not adjustment except at first few days.

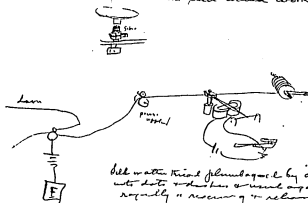
Speaking Telegraph

September 4 1877

J. A. Edison
~~Chas. B. Johnson~~
 James Adams



Perhaps electromotor instead used would work in X.



44

Speaking Telegraph.

September 4 1877.

Edison
Chas. Batchelor

Experiments with metalization of silk fibre -
 Redirections given in Rosiers book on Electro-Metallurgy that it
 does not work satisfactory with 1 gram silver in 20 grams water
 and silk well fluffed and exposing same to a saturated solution
 of Phosphorus in Di Sulphide Carbon that only portions blacken
 after 2 or three days - and even then shining black is a very
 poor conductor no where near as good as with Plumbago
 merely rubbed on - we are now trying a stronger silver solution
 with well picked fibre previously soaked all night in
 water which at the time of putting it in was boiling hot,
 after being in the silver solution about $\frac{1}{2}$ hours we took
 it out and dried & picked it then took a plate about
 7 inches diameter filled it to depth of $\frac{1}{4}$ inch with
 saturated solution phosphorus in Carbon Disulphide.
 over this a wire gauze about $\frac{1}{4}$ inch from the surface
 of the liquid - over the gauze the silk well fluffed - over
 this the big air pump receiver sealed by tress wax all
 the bottom so as to include all air.

Speaking Telegraph

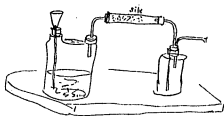
We are trying to reduce the nitrate silver to metallic silver on the silk by passing Hydrogen through a tube containing the silk thin

September 4 1877

J.A. Edison

Chas. H. Johnson

James Adams



We are also trying to pass Sulphuretted hydrogen through the tube containing the silk to reduce the nitrate to sulphide of silver which is probably a conductor.

We propose to precipitate conducting salts on the silk such as Iodide of Copper etc.

Soak silk in 10 grammes Sulphate Copper. 10 grammes Sulphate iron in 1 fluid oz water. then dry = and pass vapors of iodine through silk & to another part immerse in a saturated solution of Iodide Potassium

418

Speaking Telegraph.

September 5th 1877.

On find that silk may be easily silvered and made a conductor to be used in any speaking telegraph for varying the resistance of the line by the movement of the diaphragm. I copy her a specification which I have prepared with the idea of obtaining a patent.

" The object of this invention is to coat various materials especially materials which are non conductors of electricity with metals,

The invention consists in depositing a salt of the metal upon the material to be coated by immersing it either in a hot or cold solution of a salt of the same in any proper solvent afterwards drying it when it is placed in a tight receiver box, or closet or other proper receptacle within which is a quantity of moist Phosphide of Calcium or other phosphide of an element which slowly evolves phosphuretted hydrogen by moistening it.

The operation is as follows If any a silk garment is to be silvered, I immerse it in strong hot solution of a salt of silver preferably the nitrate of silver allowing it to remain a few minutes or such a length of time as will in extended experience be found to give the best results

Speaking Telegraph

September 5 1877

It is taken therefrom and thoroughly dried, afterwards it is taken to the tight closet & suspended over a large flat dish which is covered to the depth of say $\frac{1}{16}$ inch with moist phosphide of Calcium. By the action of the water the phosphide of Calcium is decomposed and phosphuretted Hydrogen set free, this acting upon the nitrate of silver reduces the silver upon the silk to a metallic state, the time required to effect perfect reduction is only a few minutes if the phosphuretted Hydrogen is given off in great volume.

I am aware that it is not new to reduce a silver salt upon materials by phosphorus. I am also aware that Phosphorus dissolved in its solvents such as Ether, or Bisulphide of Carbon have been placed in evaporating dishes in sealed jars over which was suspended an article containing salts of a metal to be reduced; But the use of phosphorus in solution is quite dangerous, unreliable in its action, inconvenient and very slow and it does not penetrate like the phosphuretted hydrogen to every part of the material, neither is it so energetic

412

3

Speaking Telegraph

September 5 1877

I will mention that liquid phosphorus of hydrogen may be used -

I claim as my invention

Reducing metals from their salts upon any material by exposing the same to the fumes of phosphorus of hydrogen

2^d Reducing metals to the metallic state from the salts by exposing the same to the fumes which arise from a phosphide of an element which is decomposed by uniting it

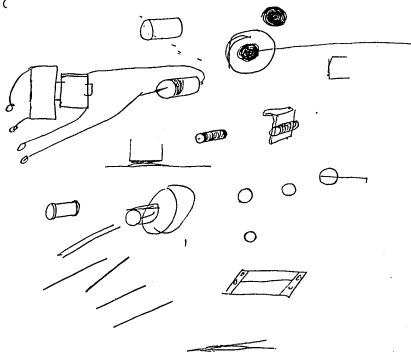
J A Davis

Charles Schuler

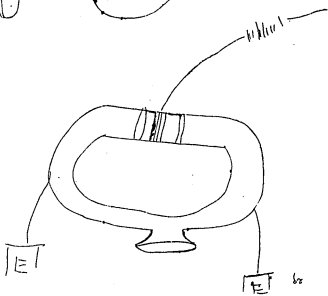
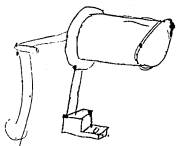
EDISON'S EXHIBIT, 151-12.

Spky Pzgyo

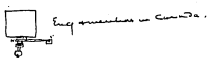
*Sept 9 1877
7a 8m*



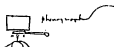
Sept 15 1877
Chapman
Adams



444 Foreign Telephone



Mention the "Canada"
+ England!



the ed.

Sept 18 1887
Zachary



James Adams
Micrograph diaphragm
on cell,



damped diaphragm

Mention "Coke" diaphragm.



425

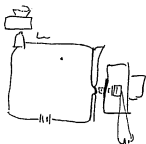
Sperry T. B. Bly

Sept 20 1877

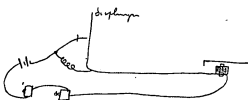
J. A. Edison

Chas. Batchelor

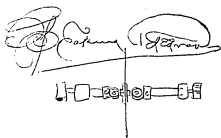
James Adams



magnetic induction
arc



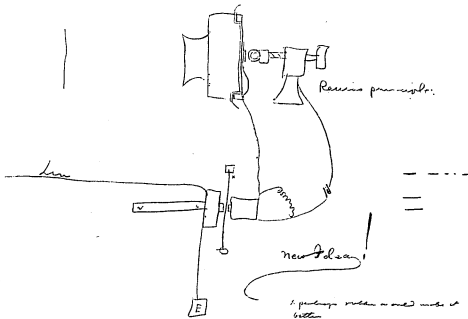
42-3



Sept 20 1877

90 Pin

Shapitelov
James Adams



422
Speaking Telegraph

Sept 20 1877

J. E. B. 1111

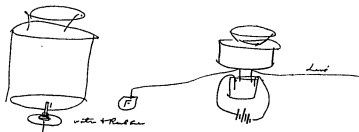
Charles Batchelor

James Adams

In place of the rubber ^{diaphragm} for pressing the ^{regular} diaphragm
in the same plane & also allowing it to be free &
thus counteract expansion & can use
of ind. ok. silk tissue, 'silk net' & cloth.

with large vibration like mine, made of
ray celluloid, asbestos silk etc.

The diaphragm is loose, may have to
harmonic described by giving cloth rubber
rather dead vibration to it.

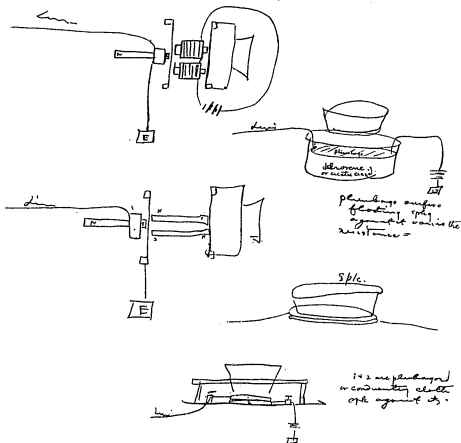


414.

Spalding 1 Diagrams

Sept 20 1977
J Adams

Chas Katchels
James Adams



220

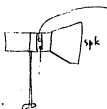
Speaking Telegraph

Sept 20 1877.

Or now dispenser with the silk floss or loose fibre with
 mineralized plumage and wax cloth, preferably silk
 cloth impregnate it with a syrupy solution of plumage
 in Distin water. The impregnation is made more
 thorough by jabbing it in by needles. It is allowed
 to dry when the cloth exhibits a beautiful
 surface, washers or rather discs are cut
 from it and these discs generally have
 13 semi revolutions strong enough much power
 when the plumage is well worked in the
 Distin Cause it to adhere with great tenacity
 to the fibre, instead of Distin any sticky
 substance may be used, or matter which when
 mixed with the plumage will cause it
 to adhere to the fibre. Uelct may be used
 the plumage being forced through the body
 & the extending plucky fibre is also
 Coated = of course peroxide he and a other
 compound in solution or finely divided
 metals may be used =

431

Speaking Telegraph



I think for you speak into a thin pipe
that the modulation will take
most care to the air & this
will generate current that
may possibly be received
upon an exceedingly delicate
diaphragm & magneto.

I propose to give battery upon the principle
of Pulsonachian. Change for my
regular Telephone =

In Damped diaphragm

Edison's Exhibit
164-12,
L. L. G.

Microdiaphragm loose & laid against
a stretched rubber diaphragm
the present the effect of expansion
& kills harmonics, both low & high
it works beautifully we
made a lot of telephones this way
and they all showed character
the big humby Dori

EDISON'S EXHIBIT. 165-12.

156

Edison

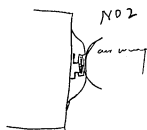
Sept 21 1877
S. L. G.
Chas. Parker



N01

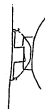
Edison's Exhibit 165-12
S. L. G.

working by movement
no adjusting screw



N02

one wing



N03

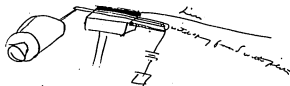
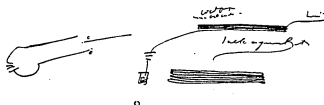
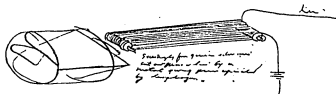


N04

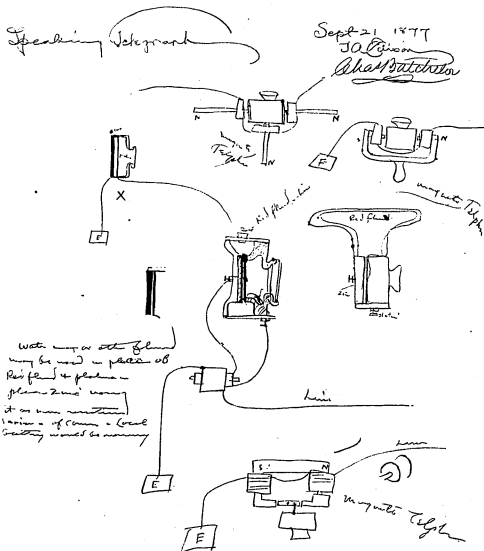
435

Speaking Telegraph

September 27 1877
J. A. Baird
Chas. Batchelor



233

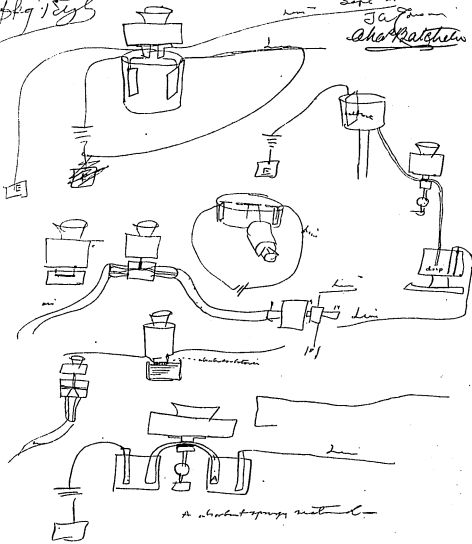


434

Edg. Ryb

Sept 21 1877

*John
Edg. Ryb*



A. Scherzer's patent

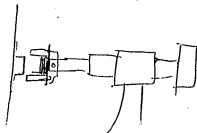
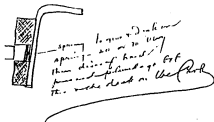
432

Speaking telegraph

Sept 21, 1877.

Dr. J. B. Smith
Chas. B. Smith

Patent
 Office

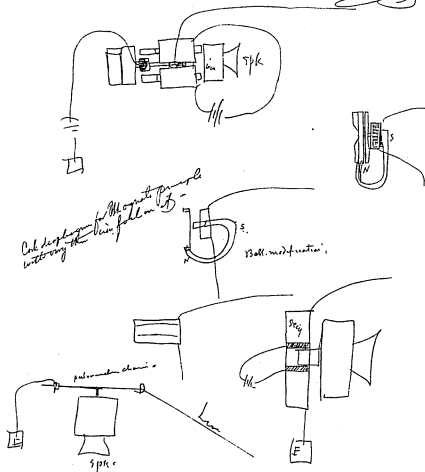


20.

27

Spiky Diagram

Sept 21 1877
T. S. Edison
Charles Batchelor



271

Sphygmograph

Sept 22 1897

Chas. B. Davenport

We find that the diaphragms change
 their position so easily by heat of the
 mouth that it is impossible to use
 a rigid fluf holder hence we go
 back to the old spring lever
 device and we find that the fluf
 works ok with it although we
 had had luck with it as solid plumbly
 we find articulation ok & moderately
 loud with resistance - fluf of
 in 15 ohms

Hocking Telegraph

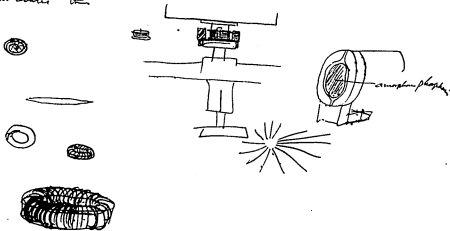
Sept 22 1877

Hub

single plumbagoed fibre wound on
thin stiff disks of plumbagoed
paper - also square disks

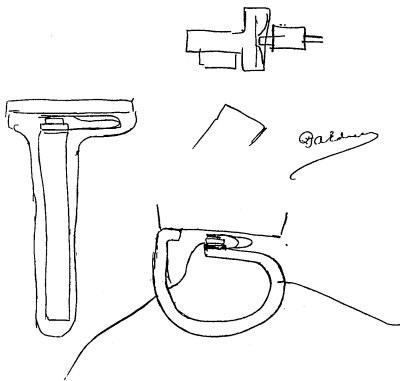


also would like a magnet with a stiff hog bristle
in center the



EDISON'S EXHIBIT. 176-12.

Sept 22/77



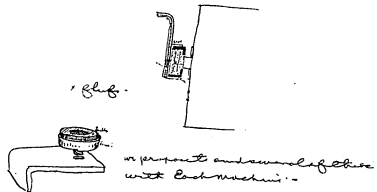
220
Feeding Paragraph.

Sept 24 1877.

Ja Edison

Warrington

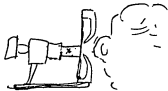
We have got the fluf by dead-to right, -
the.



Edg. B. Gl.

Sept 24 1877

Tonight while testing speaker with ordinary
 effort we had them quite loud when I had
 screen away from Patch & he noticed
 or thought he he and Jim's talking in dream
 upon investigation we found that I was
 really so had Jim try it & he heard &
 conversation was kept up few minutes
 had 12 Cell battery & current was 1200
 ohms, but at 100. could do by or if
 on him or two a little low the Exh. means
 sound would be relatively low or
 couldn't be heard at all I propose to
 conduct a series of experiments on a
 screen based on the expansion principle.
 then



X is different things.
 say

Speaking Telegraph

Sept 24 1877

30 Edison

Charles A. Chute

~~But~~ I find that it is almost impossible to find a substance that will stick plumbago to silk for insulator whole of an egg - Distin Balsam Peru; Sugar; Water; Glycerine. Boil it in Chloroform. wait until it is in fishing it comes off but I find that Asphallum Varnish sticks it on beautifully but unfortunately when the fluo are made and put in the transmitter and a signal the talking is as good as lost due to the effect of the heated plumbago on the Asphallum. Regarding the compressed fluo as this requires a natural pressure the idea occurred that certain natural such as rubber etc. would be to heat could be made mixed with plumbago. In a cylinder & if it was he could exert a dash of water & point with a screw. Joint apart it might be used as a relay by passing the current through the cylinder & expanding to close circuit.

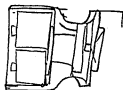
Spencer, 11th Street

Sept 24 1877
J A Edison
Chas. M. Hatch

The paper with fleishbach works good
may if not hand enough and adhesion better
than those we have in nyork & reuter 20
to 30 ohm only =

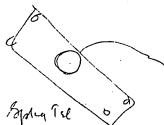
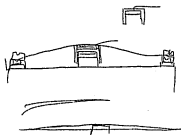
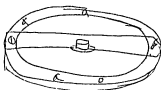
70

100.



EDISON'S EXHIBIT. 182-12.

185



Edison Tel
Sept 28, 1877.
T. Edison
Charles A. Scherer

Sept 28th 1877
 Speaking Telegraph

Charles Batchelor

Test of Instruments

No 18 + 22 Fluffs hard
 No 21 " very soft
 No 19 Speaking good Tests 120 ohms
 No 22 " " Tests 101 ohms
 No 18 " " Tests 100 ohms
 " No diaphragm of 18 was very buckley
 No 17 Talking good Tests 119. — —
 No 20 Talking good Tests 120 — —
 No 21 Talking good Tests 100 — —



EDISON'S EXHIBIT. 185-12.

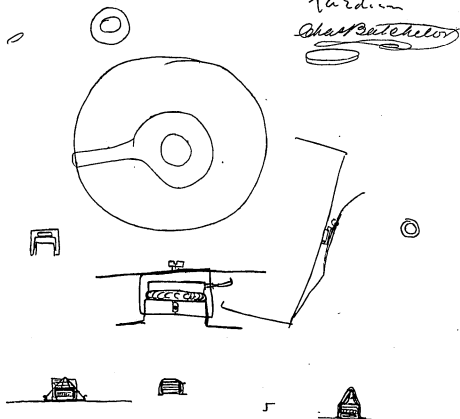
1143

Spring Telph

Sept 20 1877

To Edison

Chas Batchelor



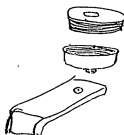
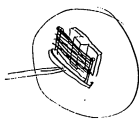
1142

Speaking Telegraph

Sept 29 1877
J A Edison
Chas. Batchelor



propose to use threads stretched as shown
which threads are plumbagoed



I believe we could coat
charcoal fibre or mineral
coal fibre or even fine spun
glass with plumbago by
using asphaltum varnish
than the stuff would
be perfectly conductive

EDISON'S EXHIBIT. 188-12.

447

Spkq Diagram

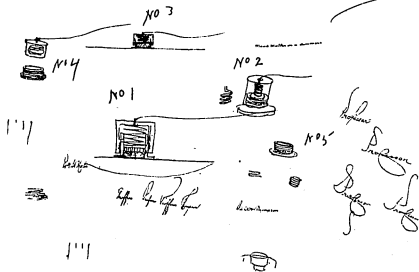
Edison's Exhibit 188-12
S. L. G.

Sept 30. 77

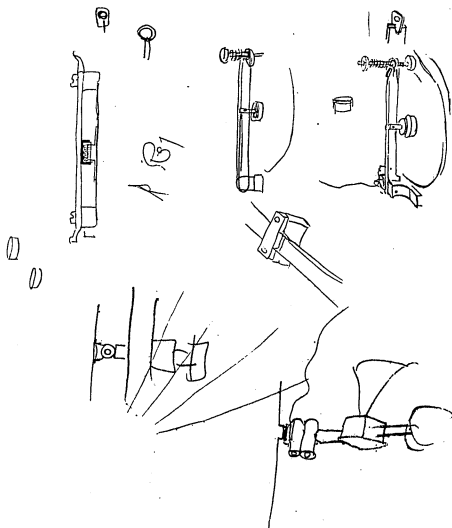
T. A. Edison

~~Edison's Exhibit~~

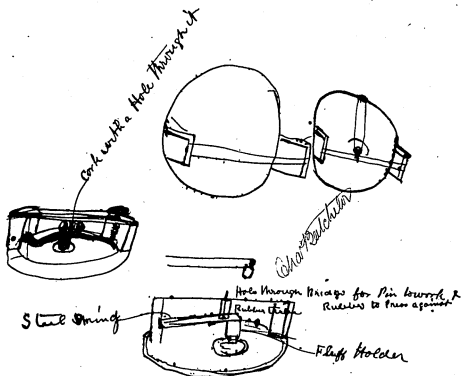
T. A. Edison



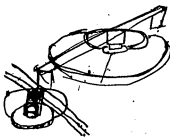
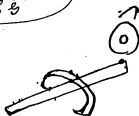
EDISON'S EXHIBIT. 189-12.



Heating telegram Oct 21 1877



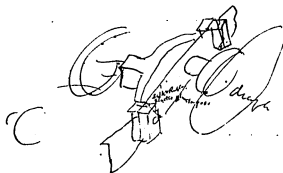
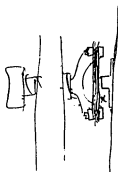
Edison's Exhibit
1-13.
L.L.G.



James Adams
Baldwin

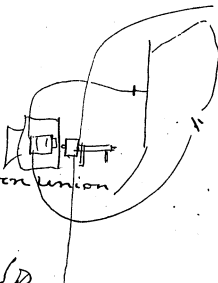
At Speaking Telegraph

Oct 3 1877
J.A. Edison
Chas. S. Johnson
J.A.E.



2 pieces of plumbagoed cloth

Waggon



Boston
Morning

Boston

Morning

Boston
Boston

Morning

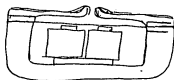
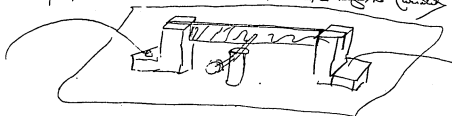
Tragash & Co. S.P.

Spkg Telph

October 8 1877
S. Edison

Chas. A. Johnson

Plumbagoed hard rubber on one side
pass the current through it that causes heat &
but going propose to connect to diaphragm & receive
talking by these expansions on the passage up to the wind



Western Union

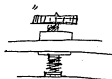
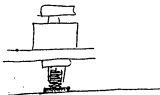
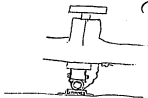
Telephone	Coastal	Western Union	Telephone
Boston Boston	Boston Boston Boston		
Telephone	Boston Boston Boston	Coastal	
		Coastal	
		Western	
		Coastal	

Speaking Telegraph

October 3^d 1877

J. A. Edison

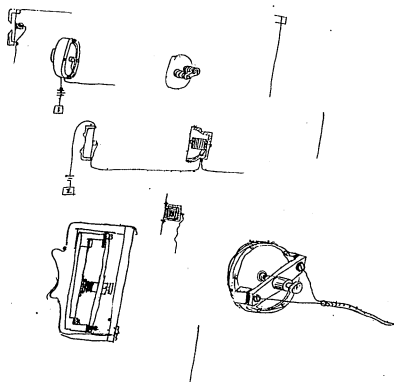
Chattanooga



EDISON'S EXHIBIT. 6-13.

Speaking Telegraph

Oct 3rd 1877
J. A. Edison
Charles A. Nichols

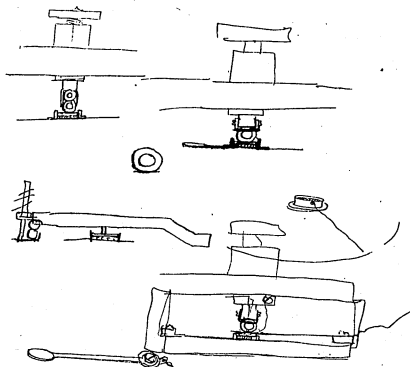


Speaking Telegraph

October 3rd 1877.

J. A. Edison

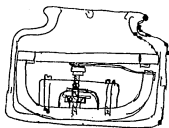
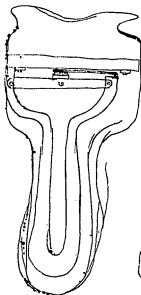
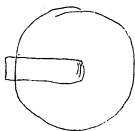
Charles Batchelor



Edisons. Exhibit 7-13
P. L. B.

Speaking telephone

Oct 4, 1877.
J. H. Brown
Charles H. Schell

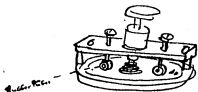


Edison's Exhibit

Dec 4 1877

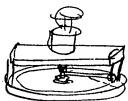
J.A. Edison

Charles Batchelor



Extra Screws for Roller to dampen the draughting

Newton Boston



Extra Screws for Roller to dampen the draughting

Newton Boston

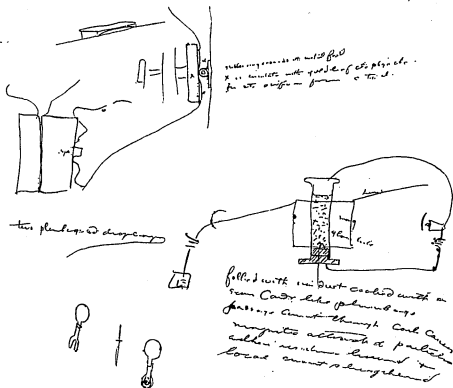
Edison's Exhibit
9-13.
S. L. B.

EDISON'S EXHIBIT. 10-13.

Edison

Oct 5 1877 T. A. Edison

Charles F. Smith

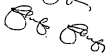


EDISON'S EXHIBIT. 12-13.

476
Edison

Oct 1 - 1877
T. A. Edison

Edison



413

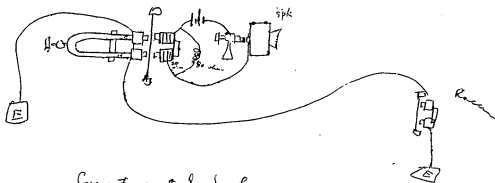
Speaking Telegraph.

Oct 5 1877

Tolshen

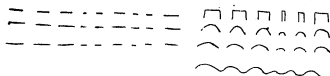
Chas. F. Smith

We have just made complete instrument for working on
the new principle of turning straight waves from a Radio
point into undulatory waves: it works, not bad



Current out loud, slow

Same strength
in magnet, therefore
diagonal wires
P. 20



EDISON'S EXHIBIT. 15-13.

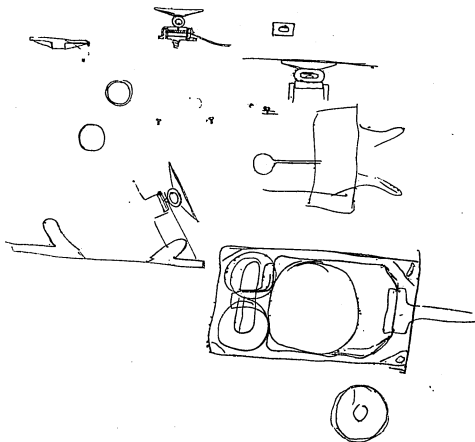
#17

3-yrly T. K. L. L.

Oct 5 - 1877

7th St. L. L.

Chas. K. L. L.



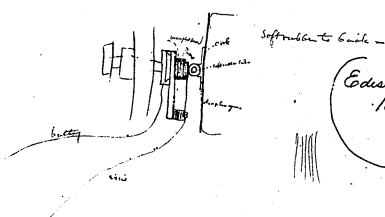
1004
 J. P. Elmy

Oct 5/1877
 Charles A. Nichols
 P A Edison

We at last adopt the small sharp edged hole to
 speak through have tried every conceivable kind
 of holes in thick & thin stuff also various shapes
 of holes & groups of holes slots etc, round
 3/16 hole pbbly best



We have adopted a new method of
 working the Semi-Conductor

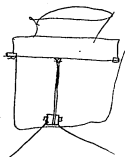


Edisons Exhibit
 16-13
 J. P. Elmy

EDISON'S EXHIBIT. 17-13.

Spec TSL

Oct 6 1877
7 a.m.
Chas. Batchelor



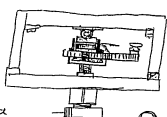
Edison's Exhibit 17-13
S. L. G.

Speaking / Telegraph

Oct 6 1899.

St. Ignace

Charles C. Batcher



Lucy

Children

now by the beard
of the prophet

[illegible]

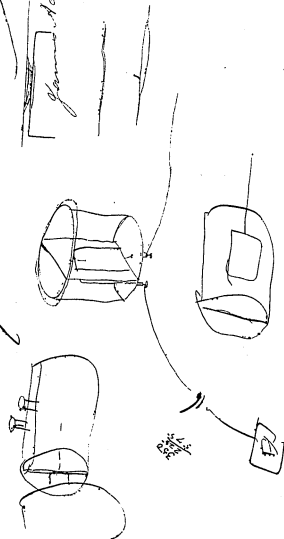
117

Wm. E. Fry

Oct 9 (1877)

74th St

James H. Adams



Spencer

Oct 10 1877
7 a 5



160
 1600 No. 7.
THE WESTERN UNION TELEGRAPH COMPANY.

This Company TRANSMITS AND DELIVERS messages only on condition, limiting its liability, and does not assume to be the owner of the telegraph message.
 Errors can be corrected only by repeating a message back in the sending station for comparison, and the Company will not be liable for any error or delay in consequence of failure of telegraph and wire system.
 The message is an UNREPEATED MESSAGE and is delivered by request of the sender under the conditions stated above.

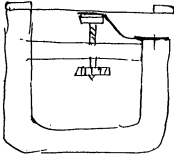
A. R. BREWER, Sec'y. WILLIAM ORTON, Pres't.

Dated _____ 187

Received at 14 Exchange Place, Jersey City, N. J.

To _____

READ THE NOTICE AT THE TOP.



Oct 16 1877
 W. H. Adams

462

Jan 20, 1877

THE WESTERN UNION TELEGRAPH COMPANY.

This Company TRANSMITS and RECEIVES messages only on condition, limiting its liability, which have been presented to it by the nature of the following message.

Messages can be transmitted only by repeating a message back to the sending station for correction, and the time taken to do so cannot be held against the sender in any case of delay or mistake of the sender or the receiver.

A. R. BREWER, Sec'y.

WILLIAM ORTON, Pres't.

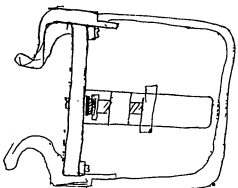
Date

187

Received at 14 Exchange Place, Jersey City, N. J.

To

READ THE NOTICE AT THE TOP.



James Adam

Oct 1/6
721.1/77

THE WESTERN UNION TELEGRAPH COMPANY.

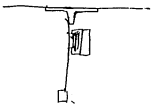
"In Company TRANSMITS and DELIVERS messages only on condition, limiting its liability, which here
is assumed by the sender of the message.
Messages are sent only by means of a key, and in the sending station for transmission, and the Com-
pany is not responsible for any delay or interruption in delivery of long-distance messages.
Messages are sent by means of a key, and in the sending station for transmission, and the Com-
pany is not responsible for any delay or interruption in delivery of long-distance messages.
A. R. BREWER, Secy. WILLIAM ORTON, Pres't.

Dated _____ 187

Received at 14 Exchange Place, Jersey City, N. J.

To _____

Telephone
over 86
7.08



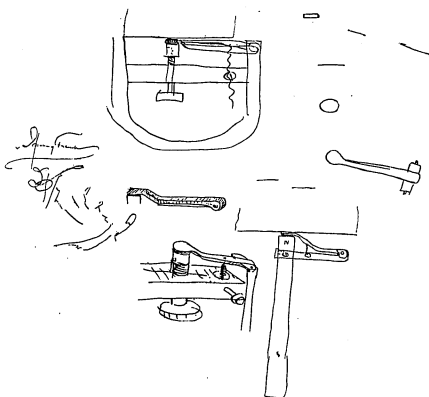
James Adams

READ THE NOTICE AT THE TOP.

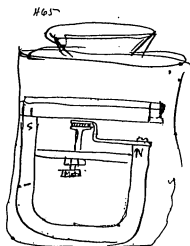
Spinning Telegraph

Oct 18 1877
Salmon

Chapman



EDISONS EXHIBIT. 27-13.

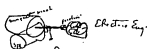


Wm. B. B. B.
Oct 18 1877
7th Edition

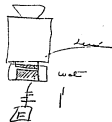
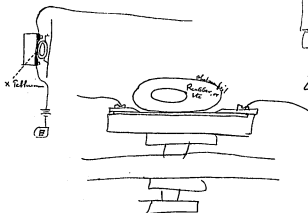
Sp. 10, 1/2

Oct 21 1877
 T. Edison
 W. B. Barstow

in a quite



Discharge in case of vacuum
 by friction results of a heavy
 magnetic current varied in strength



Instead of Tellurium, Red Phosphorus may be used

EDISON'S EXHIBIT. 29-13.

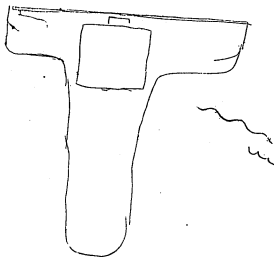
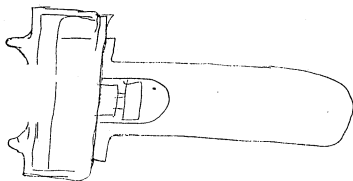
107

Wm B. E. A.

Oct 21 1877

208

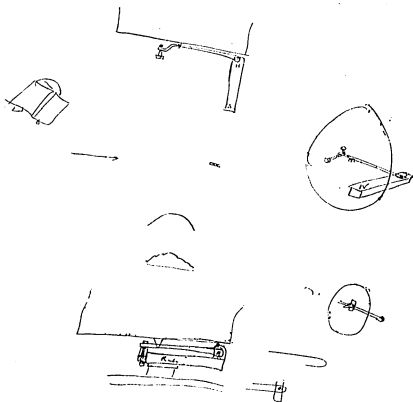
Chas. B. Atchelor



EDISON'S EXHIBIT, 31-13.

Key Telegraph

Oct 21 1877
T. A. Edison



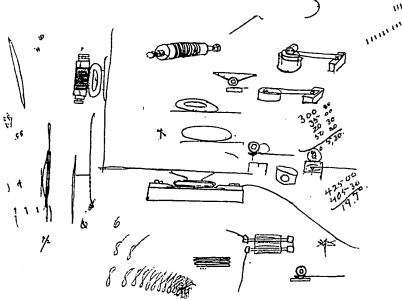
Speaking Bell

Oct 21 1877

T. Edison

Test with perfectly flat plumbago, made with diff.
Substance with flat discs as it held there by
diaphragm and piece of rubber tubing,

{ 144: 15 Grammes Plumbago
6 Grammes Rubber in B. Tubing



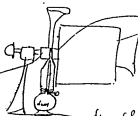
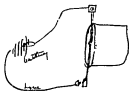
1149

Spry T. B. H.

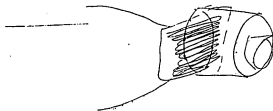
Oct 21 1877

The Edison

Charles B. Johnson



lamp. Shd. be used all time.

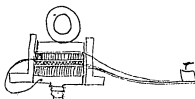
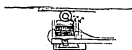


Hard Rubber diaphragm gives heat @ Cold waves
then acting on foil or other foil in a plate suspended
about 0.5 feet of it is exposed to Rubber through
which the current passes permanently. the heat
& Cold wave increases & decreases the
resistance & the given waves.

EDISON'S EXHIBIT. 34-13.

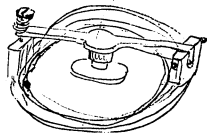
Sept 22/77
Chas. Parson

Sadler



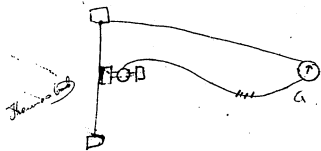
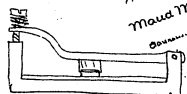
Speaking Telegraph Sept 22 1877
 79 Edison
 Chas. S. Selden

"Edison's Exhibit"
 36-13.
 S. L. S.



Boston water power
 Rochester Business Office

Maud Muller on a summer day.
 Maud Muller on a summer day.

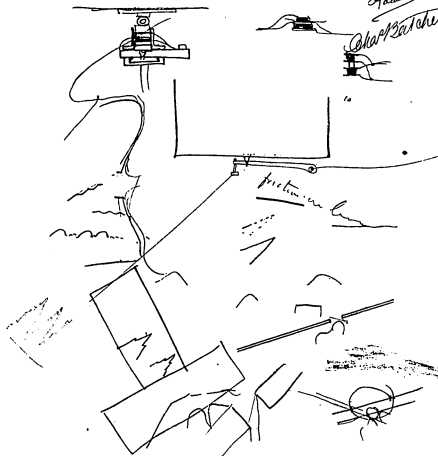


EDISON'S EXHIBIT. 37-13.

Oct 22 / 77

Tolson

Charles F. Smith

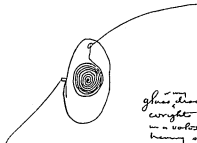


485

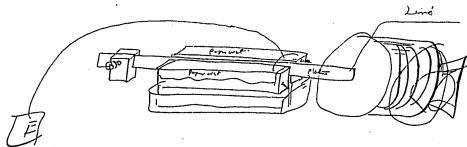
Sphagnum

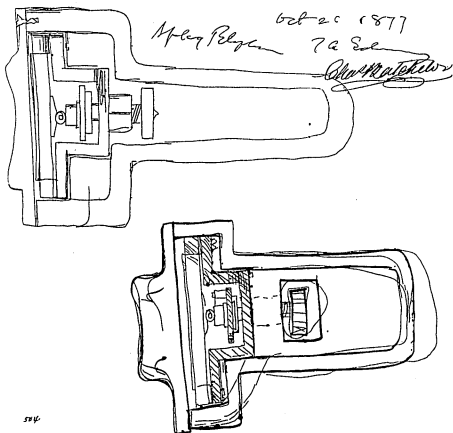
Oct 26 1877
7 A 8 o'clock

Chas. Ketchum



glass disc central with gold leaf G
wrought process and then cut
in a vertical spiral the shrapnel
having some with the spiral turned
forming through the axis vertically
in water, or it may be a spiral shrapnel
generally more regular in



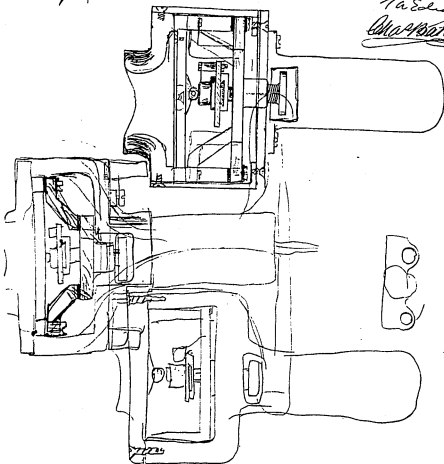


By Reason

62926 1877

7a Solen

Chas. Batchelor

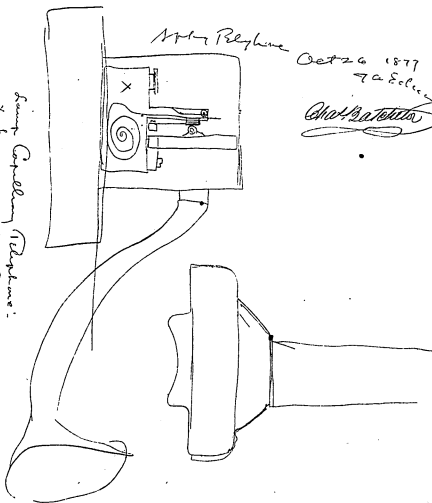


281

My Papyrus Oct 26 1877

7 a. E. C.

Chas. B. Edison



My Papyrus (Papyrus):

X has supply of the Papyrus lamp
 C is an oil lamp with a glass chimney
 when the lamp is lit the glass chimney
 is filled with smoke and the smoke
 is drawn up the chimney and out
 of the top of the chimney.

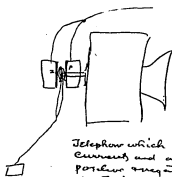
884

Sphy Telegraph

Oct 26 1877

Th. Edison

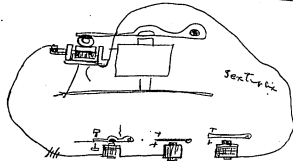
Chas. Batchelor



Telephon which generates its own
current, and also which sends
positive negative currents in
the line =



put a small telephon
in it with the
circuit to send
the word message can be
sent by the
number over the
wire

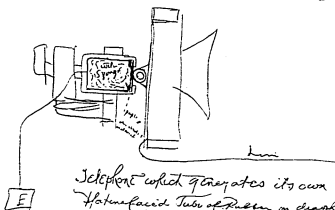


Sextonix

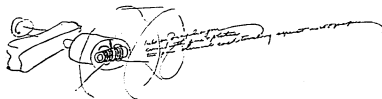
Telephony / Diagram

October 26, 1897
J. A. Edison

Chat Patented

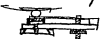


Telephone which generates its own current
Hollowed Tube of Rubber on diaphragm
If there is strong enough and it is seen to
be from the experiments we tried, then
it may be even good for intensity



we tried experiment tonight that was very successful in showing

Thermit Make 4 of these (Gordon's) telephones
 right away Complete
 enough piece just a flat piece of rubber or 
 Rubber piece screwed on with 3 screws
 hole in rubber exactly same

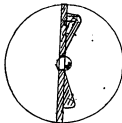
Would like ant. adjustment on the spring
 like this  + an insulator connection screw

on body to wire to connect to

Have man help

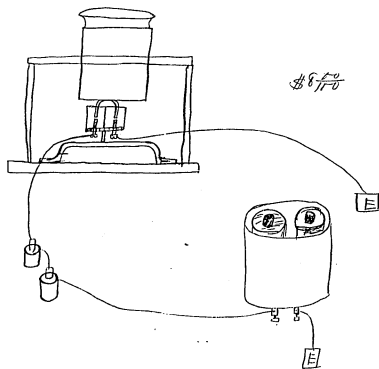
Batchelor Oct 1912

Gordon



Aug 22 goodrich telephon	5	hms	At
" 23 " " "	22	"	"
" 24 " " "	1	"	"
" " Shop work with Plumbers	2		
26 th telephon	20		
27 "	7		
28 "	9		
" Shop work	4		
" Shaving Machine	2		
" Expenses for ditto			\$1 ²⁵ / ₁₀₀
29 Telephone	4		
	76		

Aug 30th Speaking telegraph Model



EDISON'S EXHIBIT. 46-13.

X Oct 25	Staff and 7 hours	7 "
" 26	Days & hours for flats cuts	8 hours
" 27	Telephones	2 "
" 28	Receiving engine	2 "
" 29	Flats cuts	6 "
		<u>26</u>

Sept 14	Speaking telegraph	10 hours	At	
" 2	" "	9	"	
" 7	Left-hand Split Pie	4	"	
" 14	8 Stations of telephones at \$6			\$36
" 23	12 " "	" 86		\$72
" 29	2 Call Bells at	1.75		\$3.50
Oct 1	Telephone	8	"	
" 2	" "	8	"	
" 3	" "	2	"	
" 4	" "	14	"	
" 6	" "	16	"	
" 7	" Experiment	3	"	
" 8	" "	6	"	
" 9	" "	7	"	
" 10	Pattern for telegraph	1	"	
" 14	Experiment on telegraph	10		
" 15	12 Stations of telephones at \$6	75		72.00
" 22	Call Bell at \$1.75			38.50
" 11	Experiments on telegraph	17		
" 17	" "	11		
" 18	" "	22		
" 19	" "	20		
" 20	" "	9		
" 21	Krugger's man \$8 at 175			\$14.96
" 21	telegraph Experiment	89		
" 22	" "	<u>85</u>		
" 23	" "	<u>211</u>		
" 23	" "	6		
" 24	" "	19		
" 25	" "	5		
" 26	" "	9		
" 27	" "	8		
" 28	telegraph Model for Murray			
" 29	fixing for his telegraph	12		
" 29	Murray Newark	9		
" 29	telegraph	4		
" 30	" "	<u>9</u>		

1186

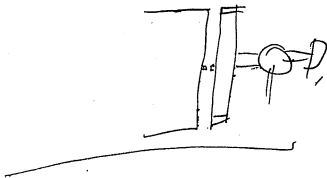
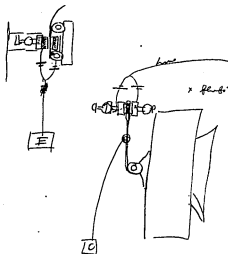
Speaking Engraver

Nov 1, 1877 =

T. A. Edison

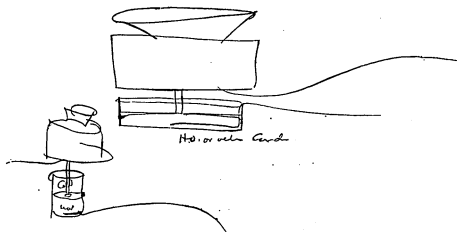
Chas. B. Schute

Remond Chute



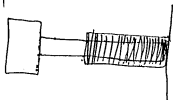
Sptg Trough

Nov 1 1877
T Edison

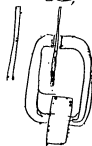
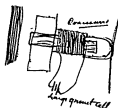


speaking Trolley

Nov. 1 1877



stretch magnetizing coil
wound on plastic, having
the maximum number of
magnetizing power by
stretching a small wire,
connection,

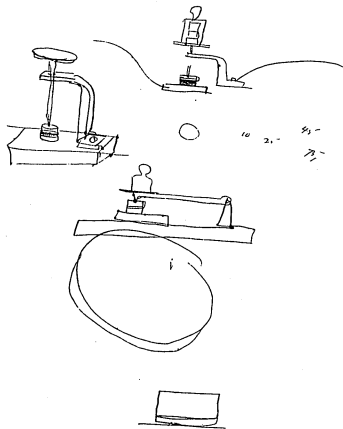


line.

^{NY}
speaking tel

Nov 1 - 1877

Chambers

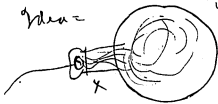


Atty Bligh
 Thursday Page 27 Vol 11 Remarks
 Nov 3, 1877
 TA Edison

Good Conductors - Galena - Sulphuret of iron =
Arsenical pyrites = native sulphuret Copper + iron
native gray antimonial sulphuret of ~~iron~~ copper
Sulphuret of Bismuth green + Copper globules of
oxide of burnt iron. oxide of iron by heat or
scale iron = Conduct current single thermo
pile well = ^{not} for oxide of Manganese + peroxide
of lead conduct moderately well.

A solution of Sulphate of Potassium is a remarkably good conductor also, greenish nitrous acid-sulphat. has as action on the metal ~~under~~ non-plateation
together.

idea =



side of lampblack.
thrust the foil in and
roll against it or
coat it with thick gres
foil. continuing foil on
to paper. X. the foil will
adhere there & will
foil black against it

Speaking Telegraph

Nov 5 1877

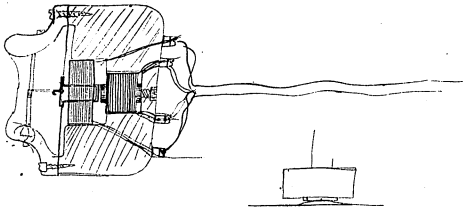
J.A. Edison

James Adams



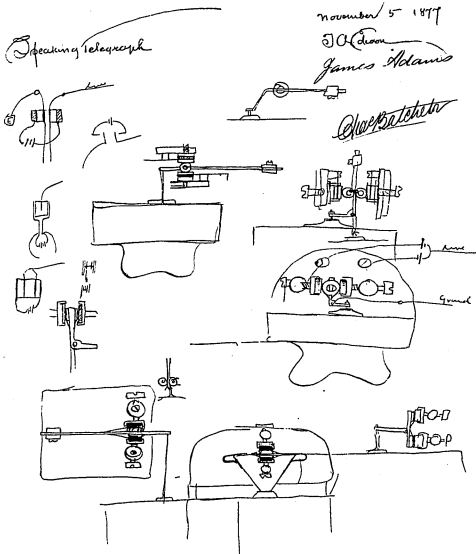
X/ # #

On phonograph I propose having a cylinder 10 threads or pulleys
grooves to the inch cylinder 1 foot long in this the full of proper thickness
arranged with cylinder in contact with cylinder 4 feet running in this
groove as seen the other cylinder rotated. I have tried many before
but was able to obtain any satisfactory surface but find that the following
arrangement is the correct of all & this cylinder will insulate about 20% spoken
words & reproduce them from same cylinder =



Edison Exhibit
54-13,
P. L. S.

490



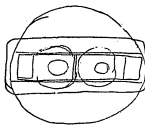
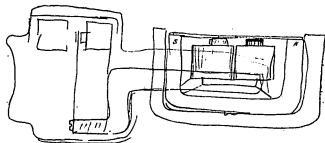
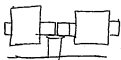
#93

Spdy P. Rogers

Nov 4 1877

T. A. Edison

James Adams

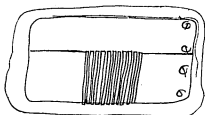


496

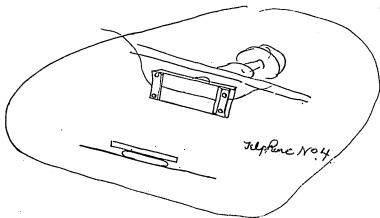
J.A. Adams

Nov 5-77

James Adams



Re Eric R. R. R.

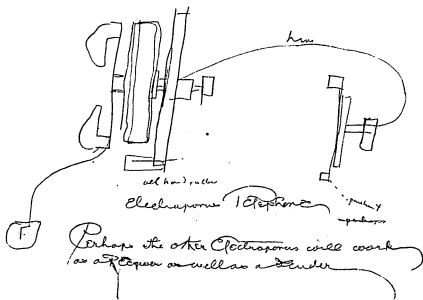


Telephone No. 4.

1197

Edison & Stephens

Nov 5 1879
J. A. Carson
James Adams

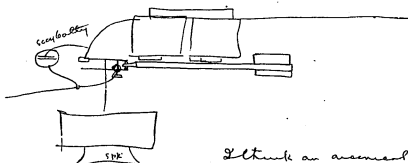


448

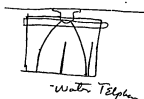
Edgely Telephone

Nov 2 - 1877
Halden

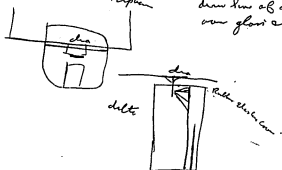
James Adams



I think an increased number
anyway or better as in March
that would be good thing to
very valuable as to cost as a
result to be used by display
try the Commoro



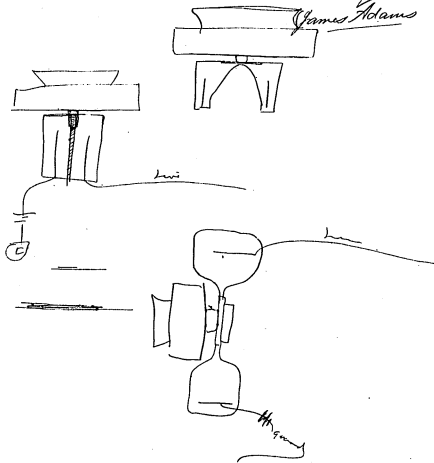
draw for a spread with silver
over glass a red line by provided silver



EDISON'S EXHIBIT. 63-13.

499

Nov 5-1877.
Talbott
James Adams



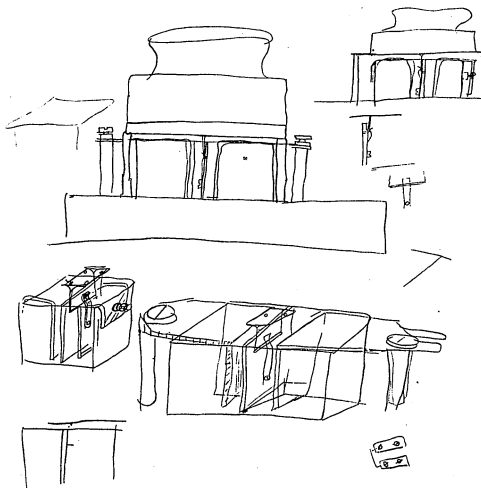
379

Speaking Telephone

Nov 5 1877

J. A. Edison

James Adams

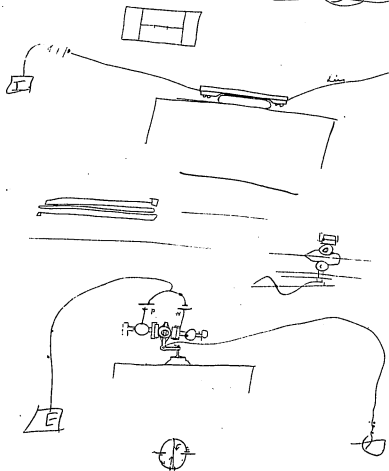


Edg. Ryan

Nov 5 1877

Tallah

Charles F. Smith



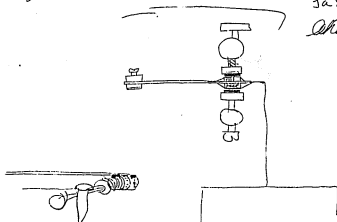
Nov

Sperry Page

Nov 1 - 1877

Ja Edison

Wm B. Ratchford



505

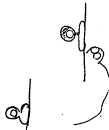
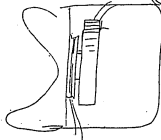
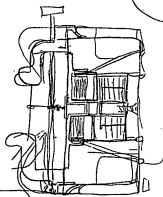
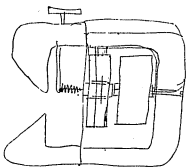
Speaking Telegraph

Nov 5 1877

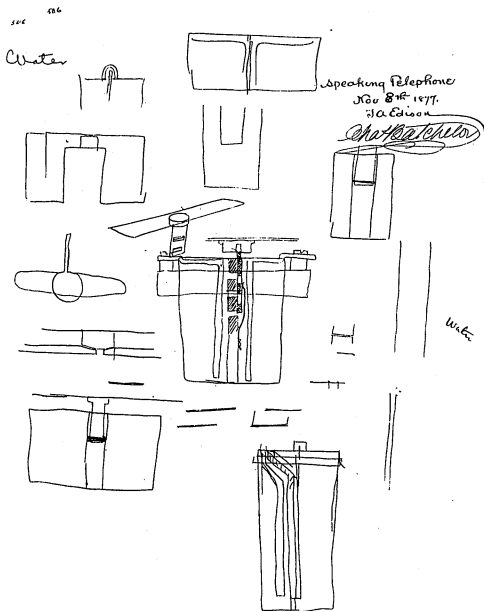
To Edison

Chas. Batchelor

James H. Adams



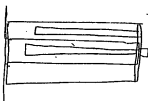
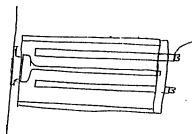
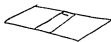
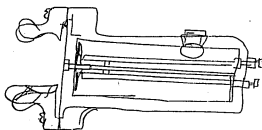
EDISON'S EXHIBIT. 69-13.



EDISON'S EXHIBIT. 70-13.

Patented 1877

Drawn 1877
J. A. Quinn
Charles A. Quinn

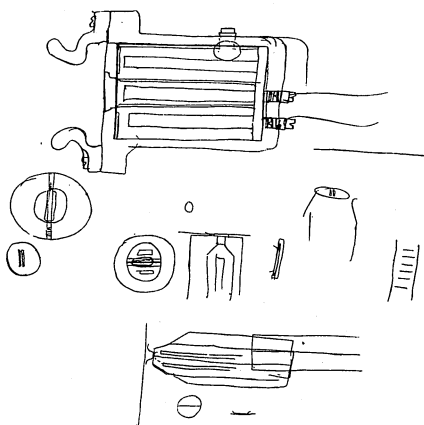


speaking Telegraph

November 8 1877.

J.A. Edison

Chas. F. Smith



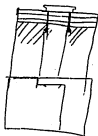
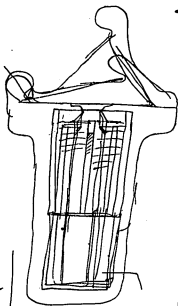
507

Speaking Telegraph

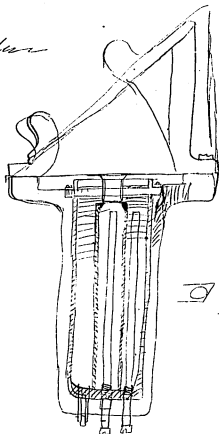
November 8 1877.

JAC

Edison



Edison's
H.C.



Nov 8 1879
J.A. Brown
Edison's Exhibit



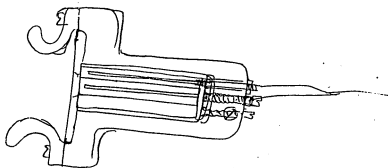
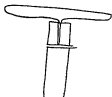
Edison's

Edison T. B. H.

Nov 8 1877

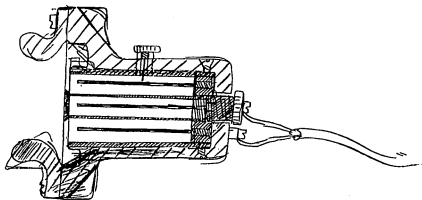
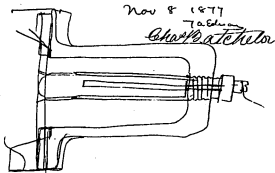
7 a.m.

Chas. A. Smith



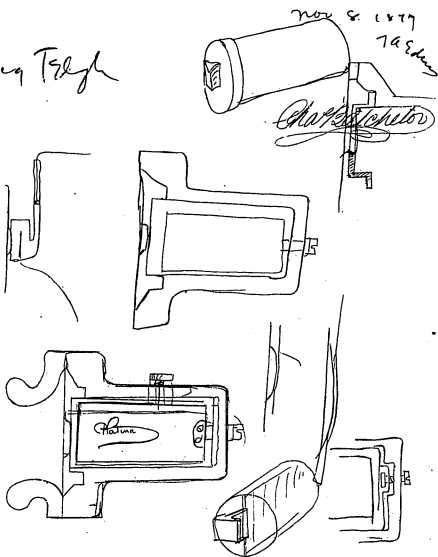
50

Epley Telephone



for

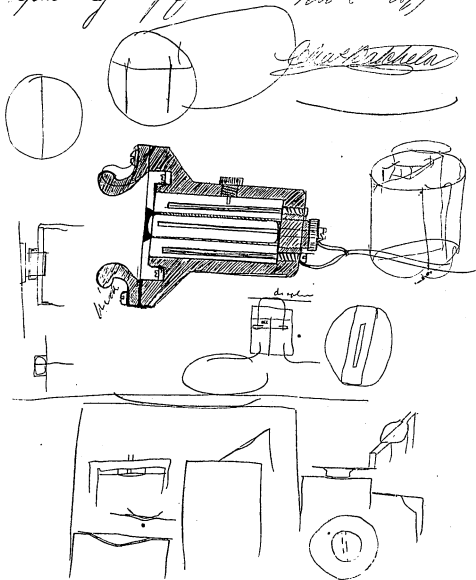
diag T. Edg



Speaking telegraph

Nov 8 1877

Chas. F. Smith

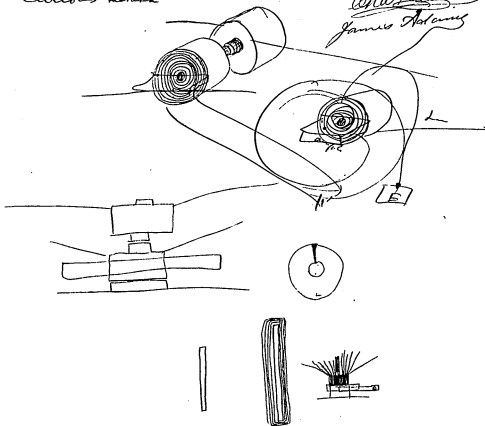


518

Breaking Repeater
Circuit method.

Nov 18 1877
T. Edison

Chapman
James Chapman



519

Spoken / ephonia

Nov 10 1547

Ja Ewan

Chas Batchelor

Wm Adams

But

Deakin to Deakin to Deakin

Don't Call

1. Answer

 $2.00' \frac{1}{2}$
$$\begin{array}{r} 12 \overline{) 4096.32} \\ \underline{36} \\ 49 \\ \underline{36} \\ 13 \\ \underline{12} \\ 1 \end{array}$$
$$\begin{array}{r} 56 \\ 49 \\ \underline{48} \\ 16 \end{array}$$

1

பெரிய

57

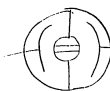
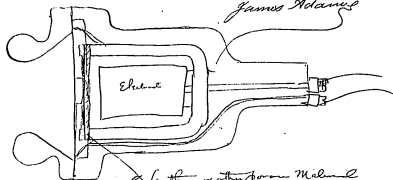
Speaking Telephone

Nov-10 1877

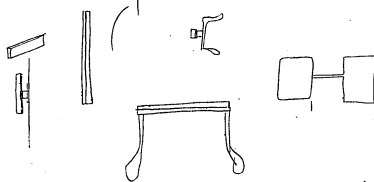
T. A. Edison

Charles A. Smith

James Adams

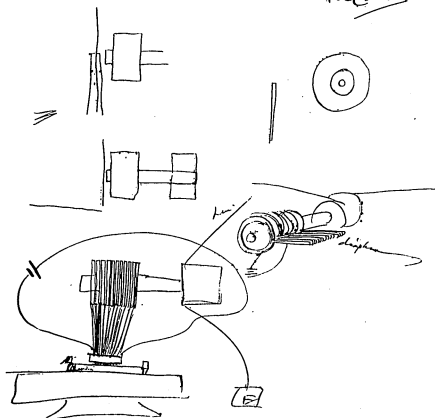


Leather or other porous material
air space for free circulation
of the air to allow expansion
admission or water around
them leather pably best or
H.O. Dantago through so good



making Peligh

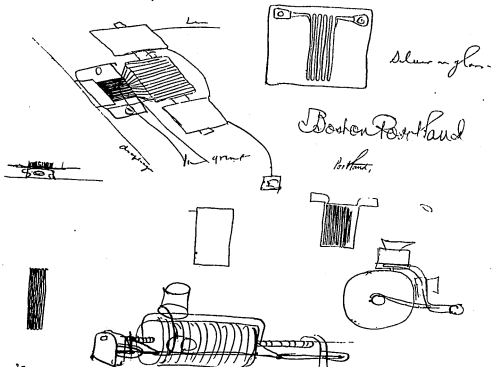
Nov 10 1877
J A Edison



Speaking Telegraph

Nov 10 1877
J.A. Brown

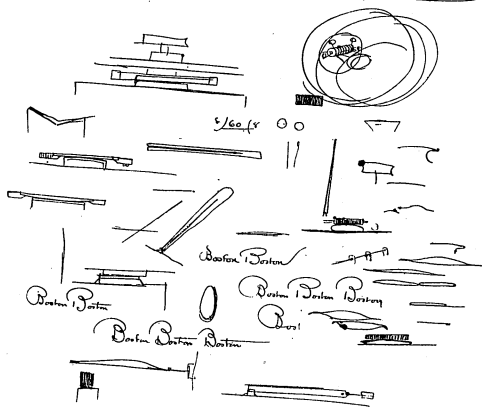
Boston Boston



phonograph: 10000 per + the full over
it 10 times to make air cylinder

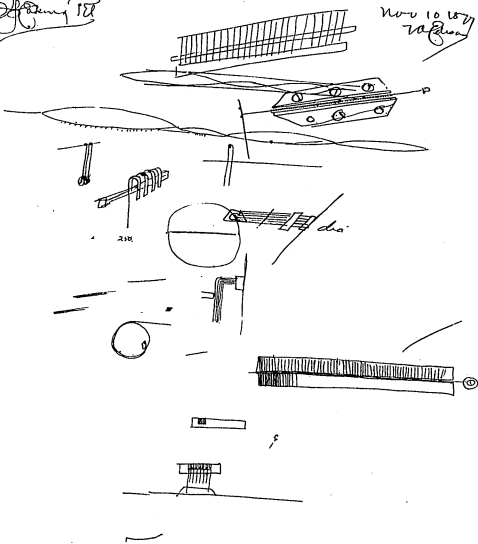
Spring Telgr

Nov 10 1877
Taldin



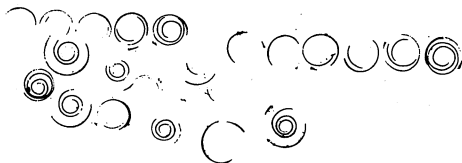
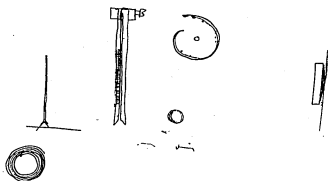
Henry 18

Nov 10 1877
Edison



R
Speaking telegraph

Nov 10 1877
Edison



Speaking Telephone

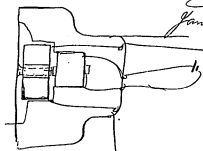
Nov 10 1877

to Mr

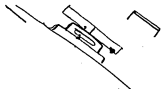
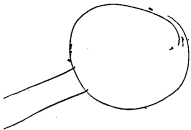
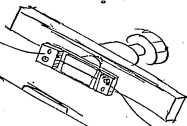
Charles A. Latham

from Mr Adams

Am.



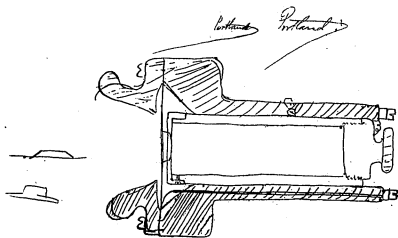
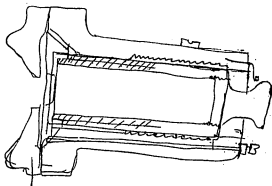
E



225

X60-10. 1877

Chas. Batchelor



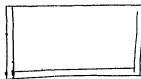
calling telephone

Nov 10 1877

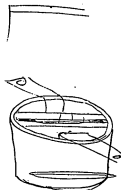
To Mr.

Charles B. Johnson

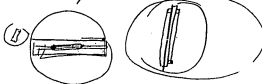
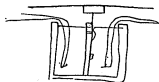
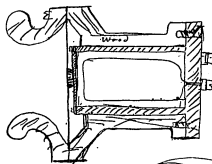
James Adams



2 1/2 in.
1 1/2 in.

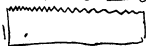


500.
500.



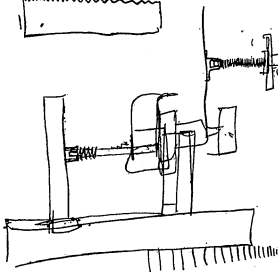
528

Spring Plug



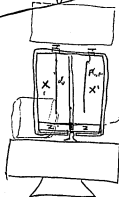
Nov 12 1877

J. W. Edison
Charleston, S.C.

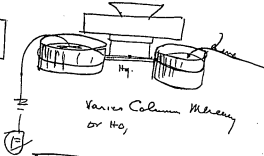


Open Plug

Nov 12 1877
J A Edison



X 4 X has low Res Electrolyte
2'4 2 is cell filled with
pure water very small.

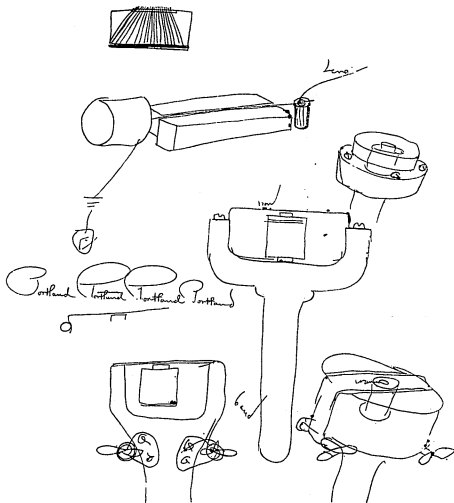


SV

Edison's Telegraph

Nov 12 1877

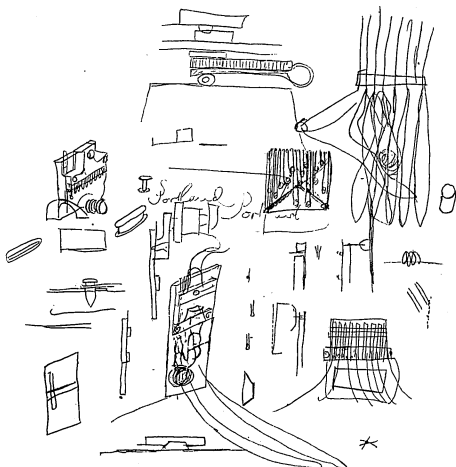
JA Edison



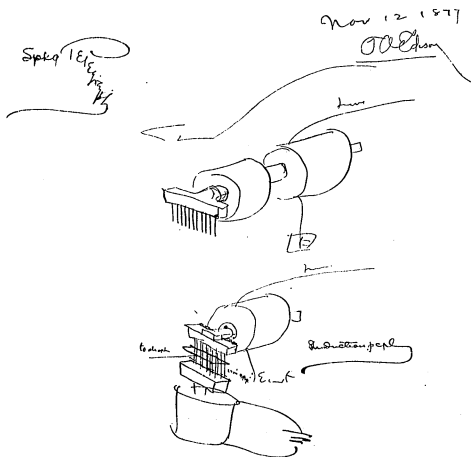
Apky Blyth

Nov 12 1877

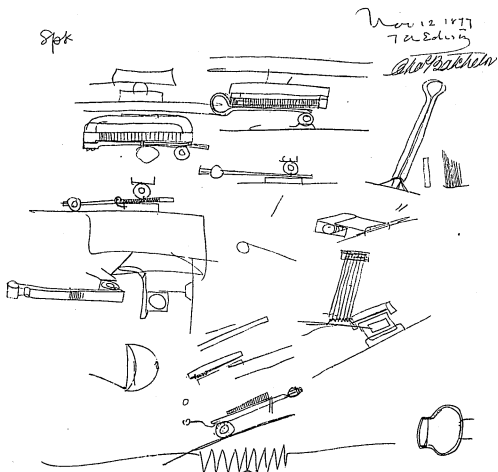
T Edison
Charles F. Smith

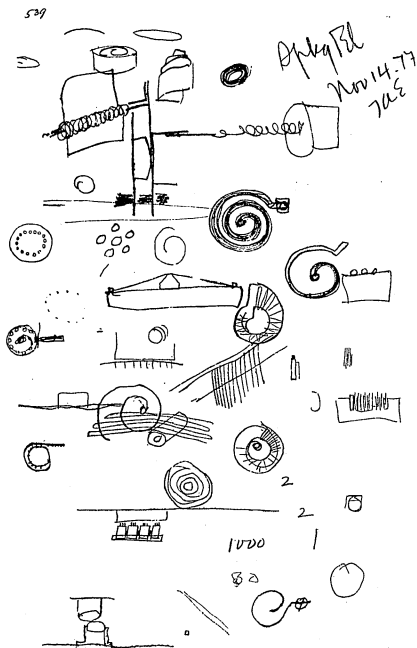


37

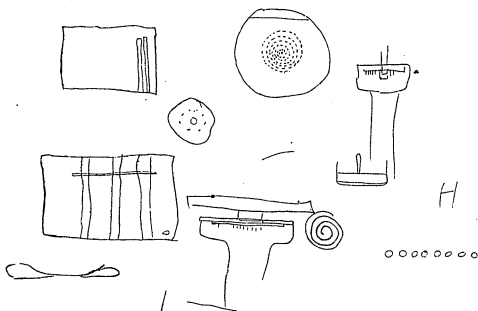


EDISON'S EXHIBIT. 104-13.





538



applied
Nov 14 1877
James Kaane
TAC

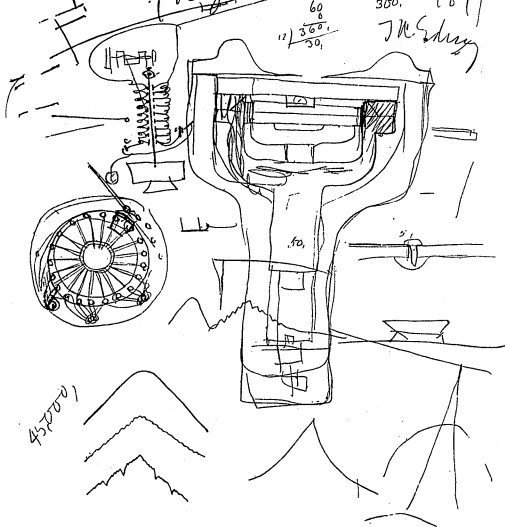
540

Speaking Telegraph

Nov 15-1877

60
12) 360
30

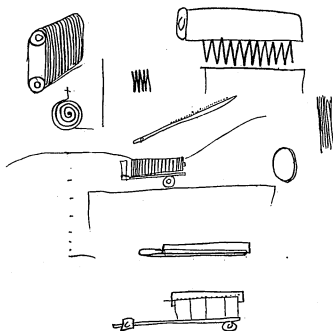
J. M. Edison



545

Phy Telephone

Nov 16 1877
J Edison

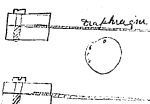


523

Speaking to myself Nov 17, 1911
Sunflower pattern

Chas. B. Butler

No flange diaphragm to bind all round



Two flat rings with diaphragm
clamped in between leaving plenty
of room for screws outside of edge
of plate

Same but top plate recessed to thickness
of plate



Diaphragm recessed - cut frame and
a ring screws into ring too
tightened up on the diaphragm.
This would be sure to bind all over



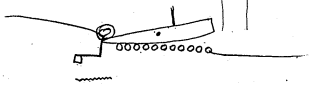
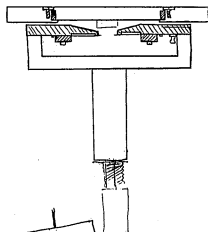
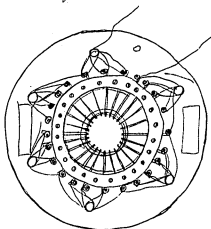
Diaphragm let in from back
and ring put in afterwards
edgewise, this is clamped
against diaphragm by screws
all round as at X X

544

Speaking Telegraph
Nov 14 1877

Sunflower

T. A. Edison
Charles F. Smith
James Adams



247

- making telegraph
Nov 17th 1877Edward A. JohnsonMethod of Clamping rotating Spring on Sun flower telephone
Spring made of hair spring

Spring bent in end and pin wedged in hole with it.

Spring held by loose washer and
clamping screwSpring soldered to collar & held in place by
screwSpring held in slot in a washer and tightened
when screwed down upon

Cross bar with 2 spikes



Small staple

524

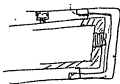
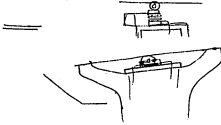
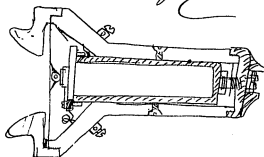
Sphylo-telegraph

NOV 19 1877

J. A. Adams

Edw. S. Adams

James Adams

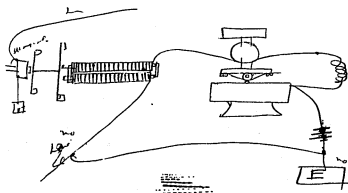


Spring Bzgh

Nov. 19. 1872



I find that stretching the wire
 were within the helix that
 helix which is already hot
 becomes hot + cold @ hot
 & less hot =

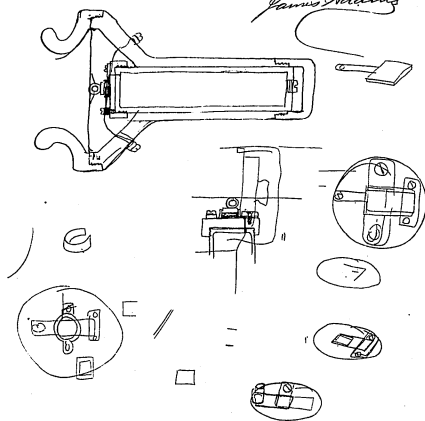


220

Speaking Telephone

Nov-19 1877

Chas. K. Chute
James Adams



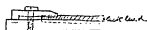
⁵⁵⁷
Speaking telegraph
Nov 20 1877

Nov 20 1877

Ths.

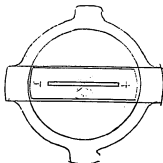
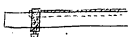
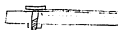
Chas. Batchelor

James Adams



Clamp to hold lead in pencil telephone

cut groove for pencil to slide in



35-

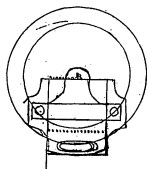
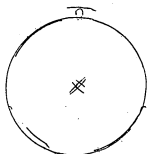
Spicer Blyth

Nov 20 1877

Ward

Edison's Exhibit

Nov 20



2/1877
16/100



556

Spley Bugh
 Wrensi =

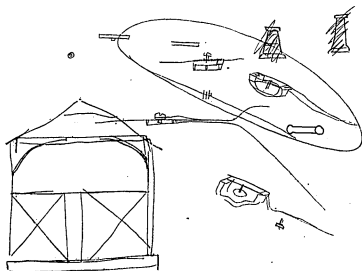
Nov 20 1877

T. A. Edison

Chas. Batchelor Nov 20

Alteration. put red lens on the piece
 like the one you put on
 the wire spool

Batchelor



557

open T22

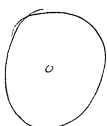
Nov 21 1877

W. E. D.



Edison & Galvani

James H. Thompson



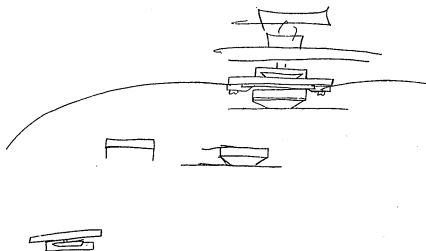
Rubber sheet



EDISON'S EXHIBIT, 122-13.

Sparking. Photograph

Nov 20 1877
J. Edison
Robert A. Feltus



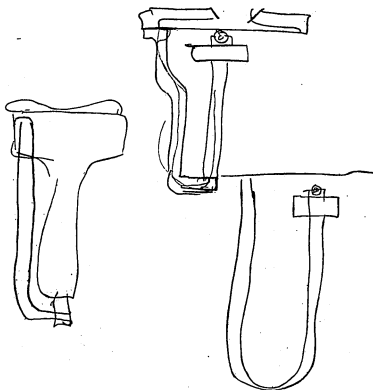
501,

Opky Reginald

NOV 21 1877

700

Chas. H. Smith

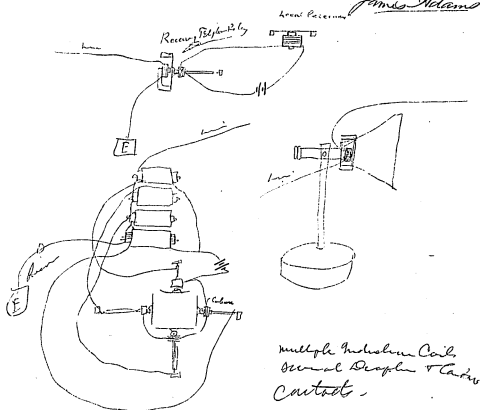


502

Nov 26 1877

7a Edw

James Adams



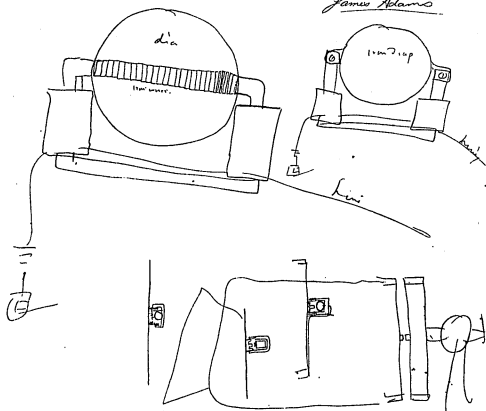
Speaking Telegraph

Nov 23 1877

J. A. Edison

Chas. Batchelor

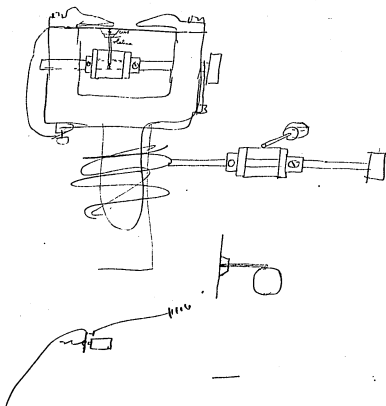
James Adams



563

W. H. P. R.

Nov 23 1877
W. H. P. R.

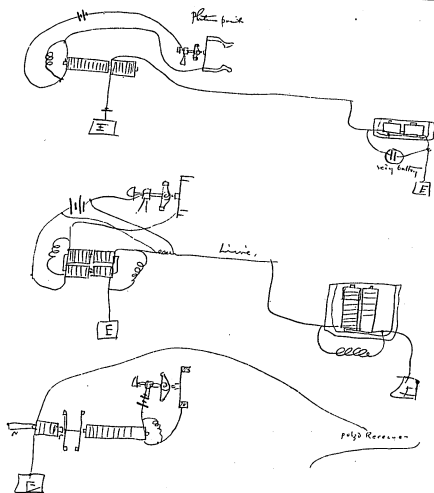


565

Speaking telegraph

November 28 1877

J. A. Edison
Chas. F. Peckham

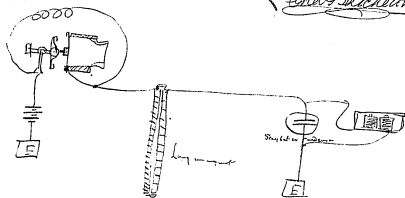


Speaking Telegraph

Nov 23 1877

T. A. Edison

Charles F. Smith

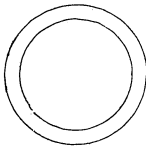
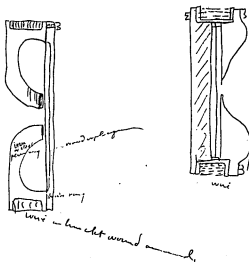


Wm. S. Paine

54

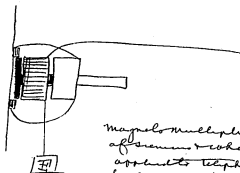
Spley Reamers

Nov 23 1877
T. A. Edison
Chas. S. Spley

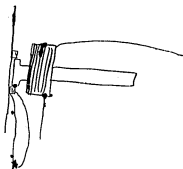
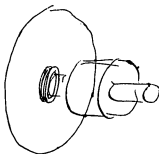
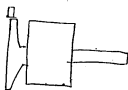


Sketching 10/29/98

Nov 23 1877
P.A. Edison

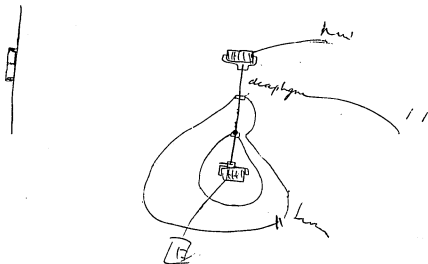
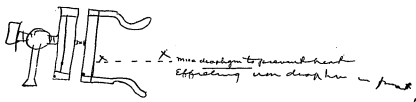


magneto multiplication
of Siemens & Kohlrausch
applied to telephony
for causing the human
voice to generate a
primary magnetization
to allow induction
being generated,



Speaking Telegraph

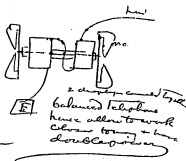
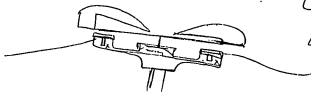
Nov 23 1877
J A Edison



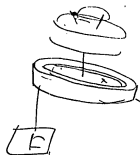
Speaking Telegram

Vol-23 1877

TA Carson



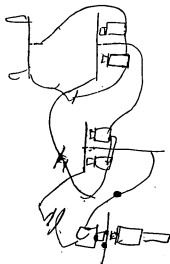
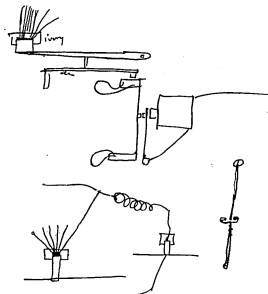
in it. a Chem Sol working as
dyeophore by the capillary
2nd ~~method~~ principle.
You can also used as the
a ~~new~~ ^{new} ~~any~~ ^{any} ~~propane~~ ^{propane}



H₂ in dash, within a coil,
 part from chattering dies in
 May 2 how hot you should
 be with by use of machine
 The women of these days
 are of point from
 chattering, rather
 indifferent comment!

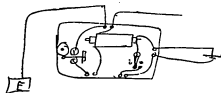
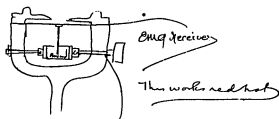
Speaking Telegraphy

Nov 23 1877
T. A. Edison



Eating Telegraph

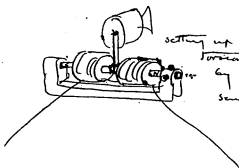
Nov-26 1877
J A Edison



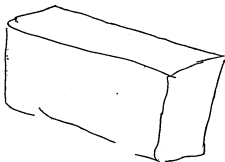
Speaking Telegraph

Nov 26 1877

J. Edison



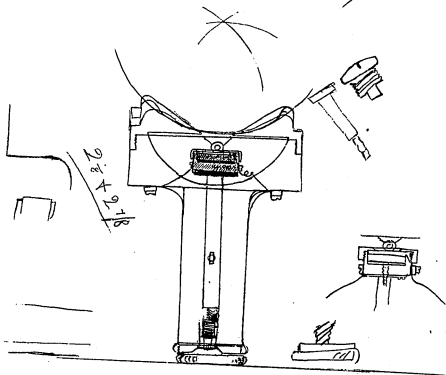
setting up induction current of
force of the permanent magnet
by the diaphragm
sends a beam sound



⁷⁶
Speaking telegraph

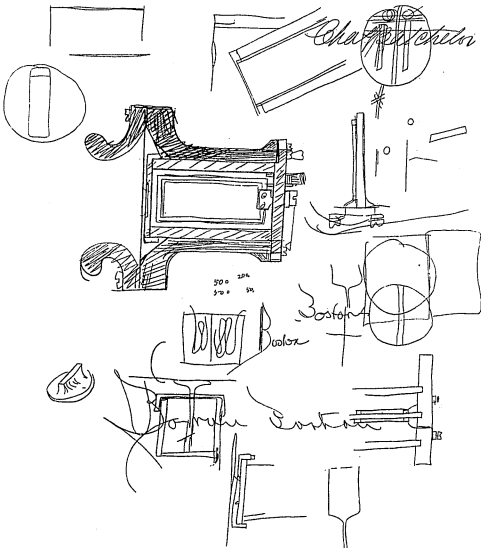
Nov. 26th 1877

Chas. Batchelor
James Adams



579
Speaking telegraph

Nov 26 1897



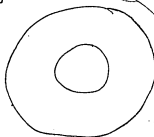
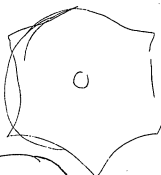
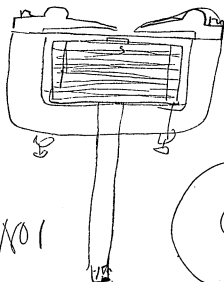
578

Speaking Telegraph

Nov 26 1877

T. A. Edison

Chas. Batchelor



2 Copper
discs

No 1

Held

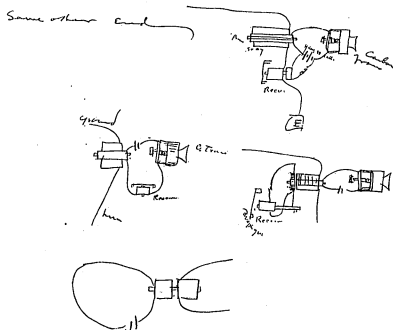
550

Speaking Telegraph.

Nov 26 1877

T Edison

Chas. H. Peckham

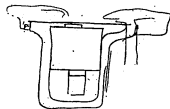
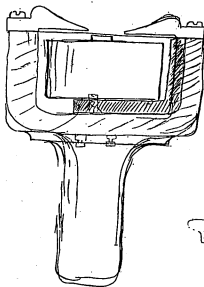


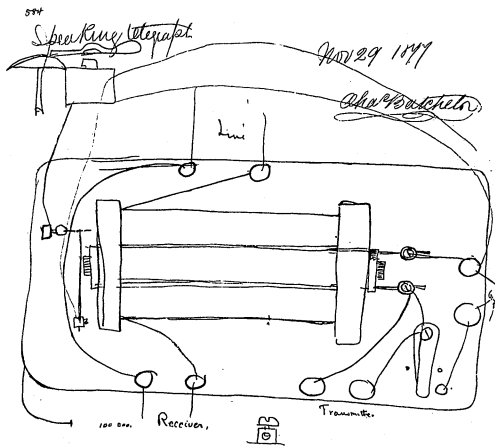
581

Speaking Telegraph.

Nov 25th 1877

Edison's Patent





500.

100.

30 ***



EDISON'S EXHIBIT. 158-13.

30 Missing 4 hrs
31 " 14 "
18

10
17
18
15
12
8
12
4
2
2
2
2 75
6
150
8
750
400
200
700
1000
6
10
7
17
18
207 75

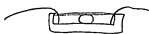
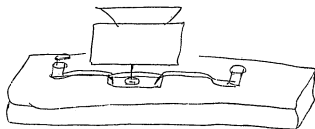
EDISON'S EXHIBIT. 158-13.

Nov 1	Telephone	14	hours
2	"	18	"
3	Samt Black Mould		
"	Cast to Edison	12	x \$1.00
4	Samt Black Mould	4	
"	Cast to Edison		002
5	Murray telephone	9	
6	"	12	
7	"	10	
8	"	10	
"	Shut Steel & Iron		004
9	Murray telephone	12	
10	"	10	
11	telephone	6	
12	"	10	
13	" Experiment	10	
14	"	10	
15	"	<u>13 2</u>	
16	"	10	
17	"	10	
18	"	4	
19	"	10	
20	"	10	
21	"	10	
22	"	12	
23	"	11	
24	Resonator	10	
25	"	8	
26	telephone Exam	11	
27	"	13	
28	"	9	
30	"	<u>10</u>	
		<u>148</u>	
		<u>x 12</u>	
		<u>160</u>	hours

EDISON'S EXHIBIT. 159-13.

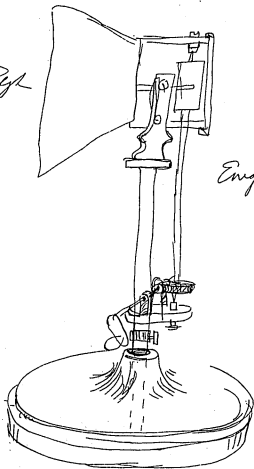
¹⁸⁷⁶
Reply Telegram

Dec 2 1877
Th Edison



507

Spky Ref



Dec 3 1877
Talman
Shackleton
James Adams
Eng Receiver

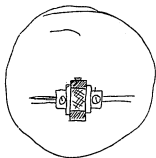
Speaking Telegraph

Dec 3 1877.

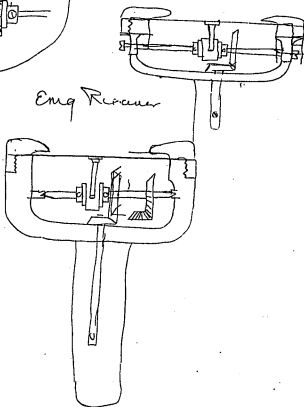
J A Edison

Chas Batehew

James Adams



Emg Receiver



577

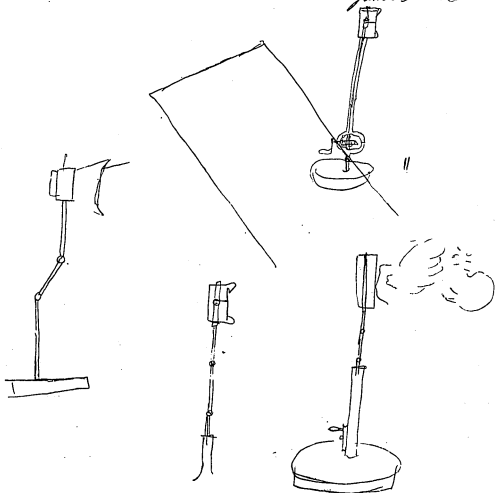
Receiving Telegraph

December 9 1877

J. A. Edison

Charles B. Davenport

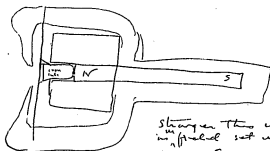
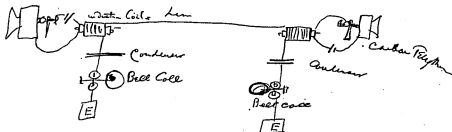
James Adams



370

Spler Pump

Dec 3 1877
 T. A. Edison
 Chas. Batchelor
 James Adams



Stronger than was
 in final set up with
 spool -

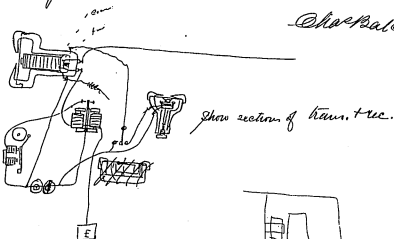
591

speaking telegraph

Model for P.O.

Dec 4 1877

Chas. Batchelor



193

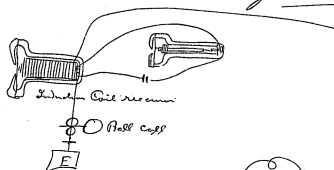
Speaking Telephone

Dec 4 1877

J. A. Brown

Wm. Batchelor

James Adams



Gettysburg Cal. Eighty Four
 Twenty Twenty
 Twenty Four
 Fourty Third

17E

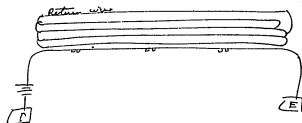
Dupl. Telegraph

Dec 4 1874
T A Edison
Chas. Batchelor
James Adams



any resistance in the ground wire will cause
induction or leakage in the telephone wire,

How to prevent =

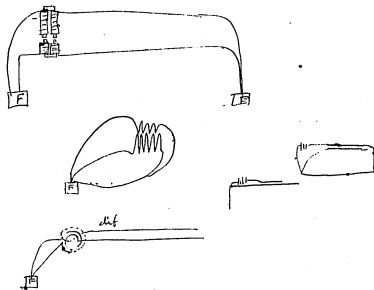


II

Compensation

Dec 7th 77

The Compensation may even be in the helix of
 the signalling net instead of the line.
 of course the principle being canceling one
evil by another similar counter
 it may be carried out in numerous ways.



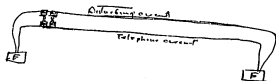
Speaking Bell

Dec 7

1877

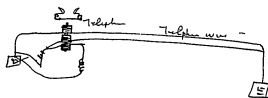
J. A. Baird

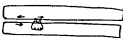
Idea occurred to me that the plan I thought of for compensating for sympathy on Quadlines from Pole to Chicago several months ago would be just the thing for destroying the kets & noise on a telephone wire. Had experiment today in New York on a telephone wire to 23rd St from 19th. Baird placed magnet in a disturbing circuit facing a similar magnet in the telephone set on working disturbing current induction due to proximity of wire outside was neutralized by the induction of the magnet when in a particular adjustment thus.



Compensating =

Dec. 7/77



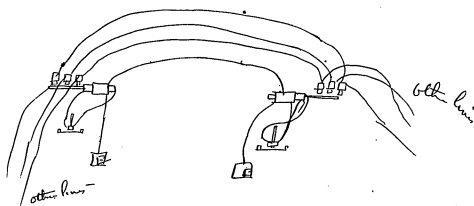
I think Coarse wire must be used
in magnet placed in circuit to
be compensated for
of low resistance;  fourth ch is

Bottom -
13

EDISON'S EXHIBIT. 176-13.

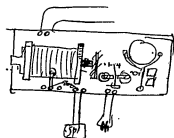
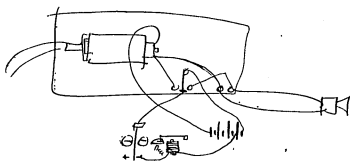
Compensation

Dec 10 1887



Speaking Telephone. "

Dec 15-1897
T. A. Edison



601

Speaking Telegraph

Dec 14 1897

Charles C. Chubb
James Adams

3 Bind posts
across the resistance
of induction Coil.

2 64 Screen $\frac{1}{4}$ long
2 64 " $\frac{3}{4}$ long
7 Binspots
1 Swivel with rubber
+ flatina pound
1 pila pta bracket
1 core

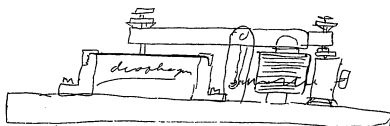
604

Spky Telegraph

Dec 18 1877

7A Edison

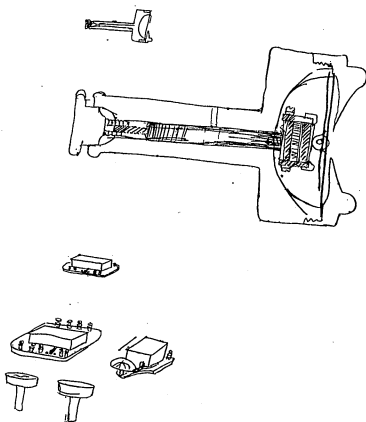
James Adams



Speaking Telephone

Dec 28 1877

J. Edison
Chas. Batchelor

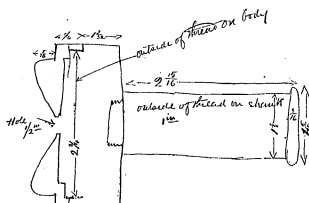
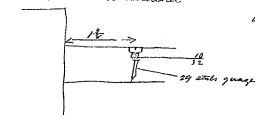


625
Speaking Telegraph

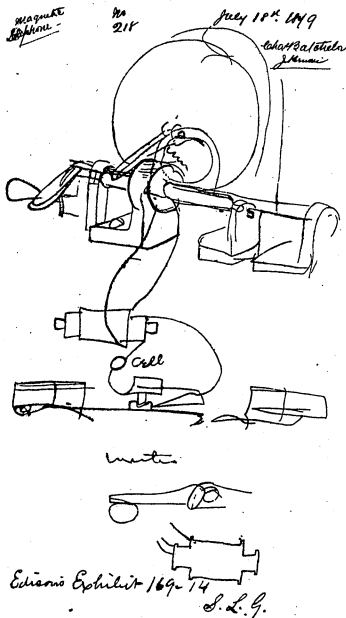
Dec 29th

Chas. B. Johnson
James Adams

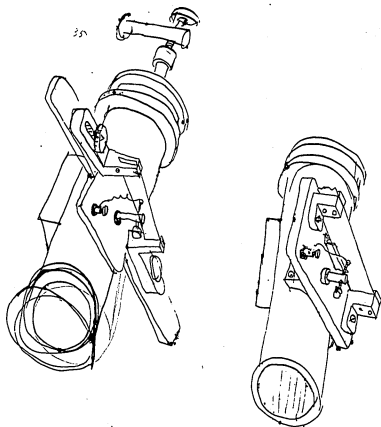
Murray model transmitter



Diaphragm of
diaphragm etc
over all
" Diaphragm.
for surface



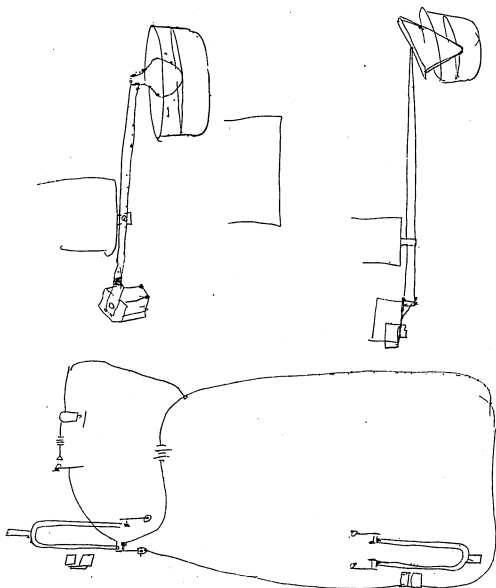
EDISON'S EXHIBIT. 49-15.

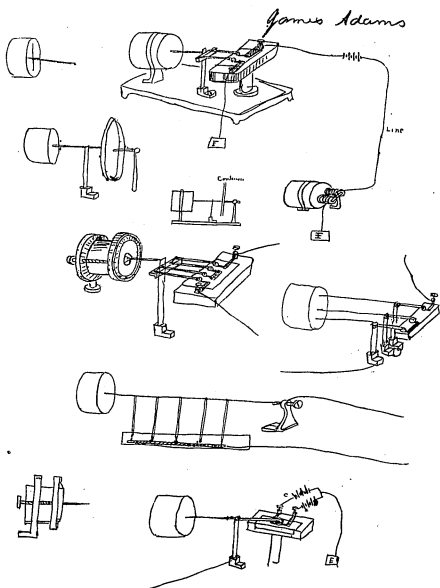


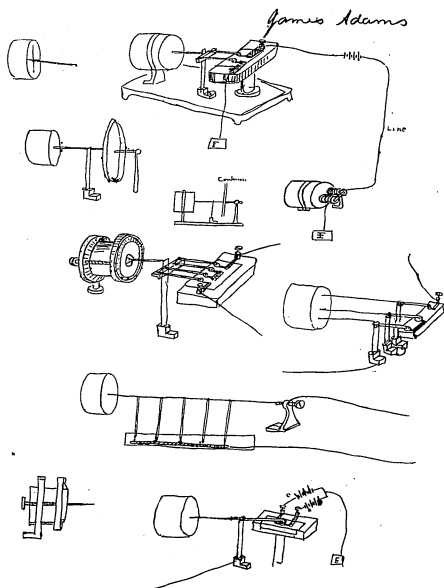
✓✓✓✓✓

James Adams

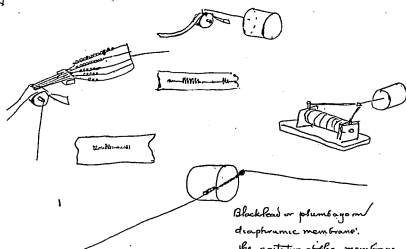
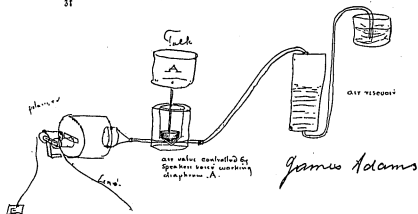
EDISON'S EXHIBIT. 79-15.



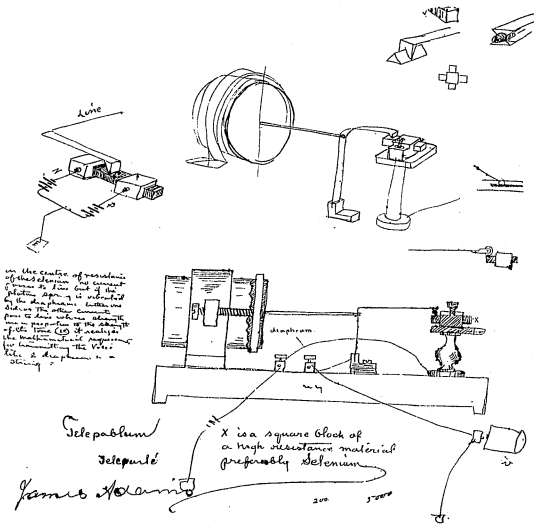




31



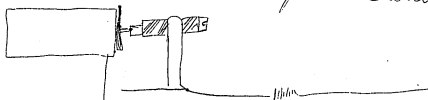
Blacklead or plumbago and diaphragmatic membrane, the agitation of the membrane separates (more or less according to high or low notes) the conducting particles and with intensity called of low quantity varies strength at each time.



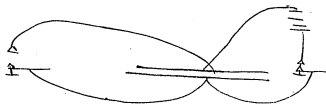
in the centre of resistance of the selenium and connect it to the line. The diaphragm is vibrated by the other current. When the diaphragm is in position it is in contact with the selenium and the selenium material is in contact with the line. The selenium is a strong

39

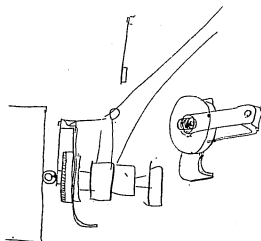
James Adams



Plasma Paint & Plasma Lustration tube. Refer with
 with different chemicals could get its best
 illumination not very good

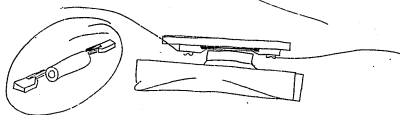


EDISON'S EXHIBIT. 111-15.



EDISON'S EXHIBIT. 117-15.

James Adams



10/

A handwritten signature, possibly "J. Adams", written in a stylized, cursive script.

EDISON'S EXHIBIT. 118-15.

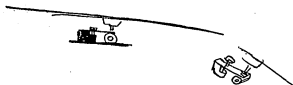
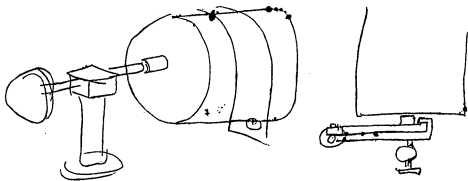
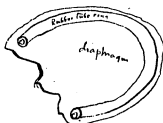
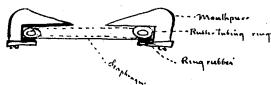


Exhibit 118-15
S.L.G.

*if that fellow dont go away
I am going to put lights out
and put induction coil on fire*

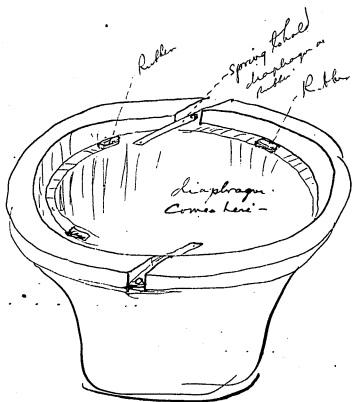


James Adams



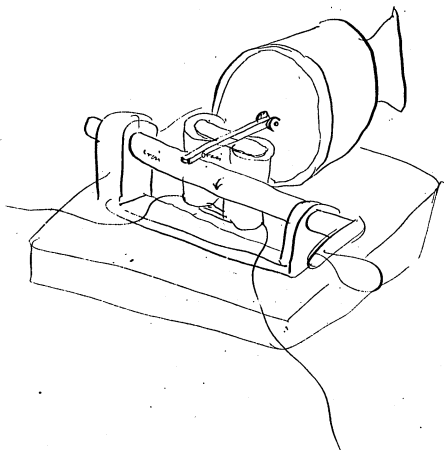
(Sketch made by witness while testifying)

"Edison's illustration of diaphragm and rubber tube diaphragm"
S. L. G. / Volney

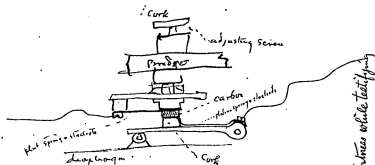


"Exhibit Edison's spring fungus Aug. 1877."
S. L. G.

Sketch made by witness while testifying.



"Edison's Exhibit
Magnetic Motograph Telegraph"
S. L. G.



Edison's Exhibit
 54-13 additional
 S. L. G.

Sketch made by witness while testifying

EDISON'S EXHIBIT.
PAGE 605.

"Cover for Exhibits"
S. L. G.

LABORATORY NOTES.



10)
of 5
Number _____

T. A. EDISON,

Menlo Park, N. J.

11-1

Journal of the Telegraph.

[April 16, 1878]

EDISON'S CARBON TELEPHONE.

Successful operation between New York and Philadelphia.

The improvement in the Telephone made by Mr. Thos. A. Edison, of Menlo Park, N. J., which increases the power of the instrument by varying the strength of the battery current in unison with the rise and fall of the vocal utterance, was very successfully tried on the 4th inst. on the Western Union line between New York and Philadelphia.

Mr. Edison's experiments with the speaking telephone were begun on about July, 1875. He was at that time experimenting with a system of multiple telephony, which had for its basis the transmission of acoustic vibrations. Being finished at the same time by Hon. William Orin, President of the Western Union Telegraph Company, with a description translated from a foreign scientific journal, of



FIG. 1.

Edison's Telephone, he began a series of experiments with the view of producing an articulating telephone. His experiments resulted in the invention of the improvement known as the Carbon Telephone, the following description of which we are kindly allowed to copy from advance sheets of Mr. Geo. B. Prescott's work, *The Speaking Telephone and other Electrical Novelties*, now in press, and shortly to be issued by Messrs. D. Appleton & Co., publishers, of this city.

"The Edison telephone, like that of Mr. Elisha Gray, is based upon the principle of varying the strength of a battery current in unison with the rise and fall of the vocal utterance. The problem of practically varying the resistance controlled by the diaphragm, so as to accomplish this result, was, by however, Mr. Edison at length made the discovery that, when properly prepared, carbon possessed the remarkable property of changing its resistance with pressure, and that the nature of these changes, moreover, corresponded exactly with the pressure. Fig. 1 represents a convenient and ready way of showing the decrease in resistance of this subject when so two or three coils of battery, and a tangent or other form of galvanometer. The carbon C is placed between two metallic plates which are joined with the galvanometer and battery in one circuit, through which the battery current is made to pass. When a given weight is placed upon the upper plate the needle shows a definite amount of pressure, which is shown by the deflection of the galvanometer. As additional weight is added, the deflection increases more and more, and by carefully noting the deflection corresponding to the various changes of pressure we can thus follow the various changes of the voice. Here, then, was the solution; for, by vibrating a diaphragm with varying degrees of pressure against a disk of carbon, which is attached to a portion of an electric circuit, the resistance of the disk would vary in precise accordance with the degree of pressure, and consequently a powerful stream of current would be sent in the strength of the current. The latter would thus possess all the characteristics of the vocal wave, and by its reaction through the medium of an electro-magnet, might thus transfer them to another disk, con-

ing the latter to vibrate, and thus reproduce audible speech.

Fig. 2 shows the telephone as constructed by Mr. Edison. The carbon disk is represented by the black two platinum plates, A and G, which are connected in the battery circuit, as shown by the lines. A small piece of rubber tubing, B, is attached to the center of the metallic plate, C, which is placed directly over the

platinum plates. Whichever, therefore, any motion is given to the diaphragm, it is immediately followed by a corresponding pressure upon the carbon and by a change of resistance in the latter, as just mentioned it is to dampen the movement of the disk, so as to bring it to rest almost immediately after the cause which put it in motion has ceased to exert vibration of its elasticity, is thus prevented, and the sound comes out clear and distinct. It is obvious that any electro-magnet, properly fitted with an iron diaphragm, will answer for a receiving instrument in connection with this apparatus.

Fig. 3 shows a sending and receiving telephone and a box containing the battery.

In the latest form of transmitter which Mr. Edison has introduced the vibrating diaphragm is done away with altogether, it having been found that much better results are obtained when a rigid plate of metal is substituted in its place. With the old vibrating diaphragm the articulation produced in the receiver is more or less confused, owing to slight changes which the vibrating disk occasions in the pressure, and which probably results from tardy dampening of the new arrangement; however, the articulation less clear and carefully well regulated that a whisper even may readily be transmitted and understood. An inflexible plate, of course, necessarily serves, in consequence of its comparatively large size, to concentrate a considerable portion of the sonorous waves upon the small carbon disk or battery; a much greater degree of pressure for any given effort on the part of

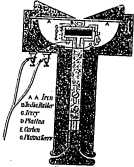


FIG. 2.

the speaker is thus brought to bear on the disk than could be obtained if only its small surface alone were used.

The best substance so far discovered for these disks is lampblack, which is produced by the burning of any of the lighter hydrocarbons. Mr. Edison has found, however, that phosphor, hyperoxide of lead, iodide of copper, powdered gas retort carbon, black

oxide of manganese, amorphous phosphorus, finely divided metal, and many sulphides may be used; indeed, tabs of fibre, coated with various metals by chemical means and pressed into buttons have also been employed, but they are all less sensitive than the lampblack, and have consequently been abandoned for the latter substance."

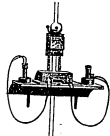


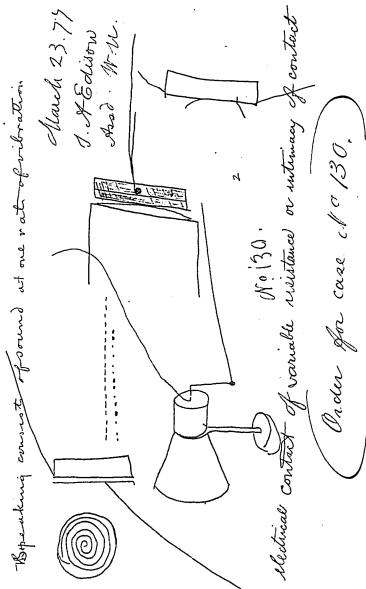
FIG. 3.

The telephone trials referred to, were made between the Western Union Telegraph building in this city, President street, Mr. E. E. Sanford, Mr. Edison, Mr. G. M. Foster, Jr., and Henry being present, and the office of Mr. Henry H. Bentley, President of the Local Telegraph Company in Philadelphia, where three were assembled Mr. Bentley, Sup't. Member, of the Philadelphia and New York Telegraph Company, Mr. G. M. Foster and several others, to test the apparatus as also the magnetic-telephone of Mr. G. M. Foster.

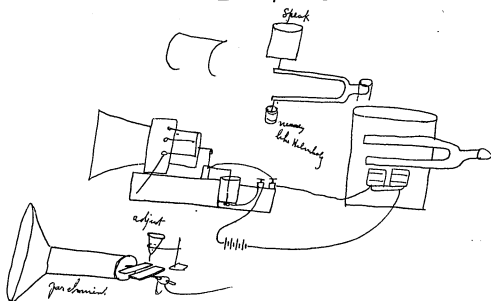
The circuit used was 100 miles in length, the line passing through a mass of wires, crossing five streams in color, and in New York passing underground to the Western Union office, which it enters with a mass of other wires. The experiments were highly successful, the carbon transmitter working perfectly; every word spoken at one end of the line being clearly articulated at the other. A number of receivers were attached to the line in Philadelphia, some of them being of the Edison's magnetic-telephone. The latter received just as clearly and distinctly as the others maintained for some time, and those of a song sung into the transmitter in New York, was repeated with surprising accuracy in Philadelphia.

The Edison's magnetic-telephone was also tried, and some transmissions by it were plainly heard, but the interference from the other wires affected it more seriously than it did the carbon, and the result was less satisfactory than with the latter.

The Edison-Gray Telephone Company has declared a dividend of 3 per cent. for the past year. Owing to the prompt action of the board in forming an alternative route the company has been deprived of revenue for only three months, in consequence of the destruction of the line of telegraph along the Black Sea coast. A balance of \$2,850 is carried forward to the current half-year.



*Translation by WU Translator of
"Reiss Telephone"*



REPRODUCING SOUNDS ON EXTRA GALVANIC WAY
BY V. LBHAT,

ROYAL PRUSSIAN TELEGRAPH INSPECTOR IN CASSIEL.

(*Supplementa VIII and IX*)

It seems not to be uninteresting to make wider known the following ideas, suggested by Mr. Philip Reiss, in Friedridslorff, in his time to the Physical Union and the Sessions of the Free German Chapter, at Frankfort on-the-Main, about the reproduction of sounds on extra galvanic way, and with regard to what has been done up to the present time in relation to realizing this idea so as to cause further efforts according to the obtained experience, and hence the most profit may be drawn from the action of the galvanic current, which already has been serving the purpose of promoting the correspondence for humanity.

The question here is not about the action of the galvanic current to cause a movement of the telegraph apparatus, no matter how constructed, to produce visible signals, but to make use of it to cause *audible signals*—to produce sounds (tones). We know that the waves of air, which, by acting on our ears, rouse in us the hearing of the sound by first of all getting the barrel of the ear in vibrating motion, thence are conveyed through astonishing fine lever apparatus, the joints of there; the experiment to reproduce sounds is based on this: to set an artificial imitation of this lever apparatus, through the vibration of a membrane, similar to the barrel of the ear, in motion, and to make use of this to open and close a galvanic chain, which is connected with a distant station by means of a metallic conduction.

Previous to describing the apparatus which is to be used, we should first take in consideration how our ear notices the vibrations of a certain tone, and the aggregate of all the tones which simultaneously act on it, because through this such requisites are determined which the sending and receiving apparatus have to perform when solving the problem now to be entertained.

Let us first of all take in consideration the processes which take place to notice a single tone by means of the human ear; then we find that each tone the action of a rarefaction and condensation often repeated in a certain space of time. If this process takes place in the same medium as our ear, then its membrane, at each condensation, is pressed towards the cavity of the drum and at each rarefaction towards the opposite side.

These vibrations determine the equal motion of the points of the ear, and the transferring caused thereby to the auditory nerves.

The greater the condensation of a sound conducting medium at a certain moment, the greater the amplitude of vibration of the membrane and the ear-joints, and inversely the smaller in a contrary case. Consequently the auditory nerves are intended to conduct each condensation and rarefactions which might take place in the medium which surrounds it with certainty to the auditory nerves. On the other hand, the auditory nerves are intended to bring to our knowledge the vibrations which occur in a certain space of time, according to number and size.

Now we give a distinct name to a certain composition; now we call the vibrations of which we become conscious "tones."

For instance, let the length of line A B be a duration of time, as you chose, and the curves over this line represent the condensations (X), the curves under the line the rarefactions ($\bar{x}$).

For instance, let the length of line A B be a duration of time, as you chose, and the curves over this line represent the condensations (X), the curves under the line the rarefactions ($\bar{x}$).

Then each ordinate erected at the end of an abscissa gives us the size of condensation in such a moment, indicated by a nadir, in consequence of which the barrel of the ear vibrates.

By no means our ear is able to notice anything more than what is produced in this manner, or through similar curves, and this suffices to bring each single tone and any connection of tone to our knowledge. Now, if more tones simultaneously are produced, then the sound-conducting medium is under the influence of several agencies acting simultaneously, which are subject to the laws of combination.

If all the powers act in the same direction, then the size of motion is proportional to the total of the powers; if, on the contrary, the powers act in opposite directions, then the size of motion is proportional to the difference of the counteractive forces.

Consequently, out of the condensation curves of several simultaneously appearing tones, according to the principles set forth heretofore, one condensation curve may be combined, which expresses exactly that which our ear experiences when taking up those simultaneously acting tones.

The objection ordinarily made in this relation, that a musician or in general somebody who is able to discern by ear the single tones, out of which this combined curve is formed and arises, does not hold good as a counterproof. So would, for example, a person familiar with the science of colors find back in green the combination of yellow and blue in their different gradings, and both phenomena might be brought back to it, being well known of these products to the factor.

According to what we have explained here before it is easy to construct condensation curves of different tones, words, &c., and it might be proper to have follow here some examples in the way of illustration.

Fig. 1, table VIII, represents a combination curve of three tones in which all the proportions of the components return in succession.

Fig. 2 represents such a curve of more than three tones, where the proportions in the drawing do not give so good an insight, but the expert musician still will discover them there, even when in practice it would be hard for him to make out the single tones from such accords.

This way to represent the action of the tones on the human ear gives the benefit of as clear as possible illustration of the whole story: we may also discover from what has been said why a dissonant (fig. 3) should affect our ear unpleasantly. This seeming deviation from the object set forth was necessary to prove, that as soon as we could possibly produce vibrations any where and on any way, whose curves and intensity are equal to such vibrations of a certain tone or a certain combination of tones, we will have the same impression which this primitive combination of tones has made on us.

The next described apparatus makes it feasible to produce these vibrations in any desired way, and the application of electricity makes it possible to give to the vibrations produced, equal vibrations at any desired distance, and so to reproduce the tone obtained at one place, at another place.

In the fig. in question 4, table IX, A is the rheotone or tone sender, and B the analyzer or tone receiver, both which apparatuses are put up on different Stations. I remark, however, as a matter of course, that the combination of the apparatuses, for alternately use to and fro, is let pass on, for the sake of clearness and likewise, (as the whole is not put there as a finished fact, but only that, which has been found out up to the present time should be brought to general knowledge). The possibility of continuation of operating the apparatuses in the present state of knowledge through the direct action of the galvanic current distance is left out of consideration, because with proper machinery this can easily be demonstrated by experiment and the material part of the explained phenomena is not injurious troubling it.

The tone-sender, fig. 4 A, is connected on one side with the wire extending to the neighboring station, and with the tonereceiver, fig. 4 B. On the other side it is connected through the battery C with the earth (or the metallic return line).

The tonesender, fig. 4 A, consists of a conical tube, $a-b$, of about 15 centimeters length, 10 centimeters front, and 4 centimeters back opening.

It has been proven on the practical experiments that the selection of the material for this tube when using the apparatus is without any influence, and likewise a larger length on it without action on the safety of the apparatus. A greater width of the cylinder impairs the use of the apparatus, hence a surface as smooth as possible in the inside wall is to be preferred.

The rear opening of the cylinder is shut off by a collodium membrane O, while on the center of the circular surface formed through this membrane one end *e* of the lever *c d* is resting, whose fulcrum *c* is held by a holder, and remains connected with the metallic conduction.

The selection of the length of both lever arms, ac and ed , is determined by the laws relating to the lever forces. It is preferable to make the arm ac longer than arm ed , in order to put in action at d the smallest movement at c with the greatest possible expression of force; on the other hand, however, it is desirable to make the lever itself as light as possible, in order that it may follow the motions of the membrane. An inexact following of the lever ed produces impure tones on the receiving station. In the state of rest the contact d, g is closed, and a weak spring holds fast the lever in this state of rest.

The second part of this apparatus, the holder *J*, consists of a metallic carrier which is connected with one of the poles of the battery *C*, whilst the other battery pole is connected to earth or to the return wire to the other station.

On the holder f is a spring g with a contact, which corresponds with the contact of the lever $e d$ in d , and whose position is regulated through a screw h .

In order not to weaken the action of the apparatus by communicating agains the back part of the membrane, the air-waves which occur when the apparatus is being used, it is preferable to put over the tube *ab* rectangular towards its longitudinal axis a disk of about 50 centimeter diameter, which firmly closes on the outside wall of the tube.

The tone receiver, fig. 4 B, consists of an electro-magnet, m m, which rests on a resonating board, n n, and which is connected with the wire to the earth, or the return wire-conduction.

Lever *i*, with the armature, is attached oscillatory on the holder *k*, and its movements are regulated by screw 1 and spring 0.

In order to increase the action of the apparatus, this tone-receiver may be placed in one of the focal points of an elliptically arched hollow of corresponding size, then the ear of the listener to the tone of the reproduced tones, is placed in the other focal point or this arch.

The action of both here described apparatus is the following:

In the state of rest, the circuit is closed.

In the apparatus fig. 4 A, by means of speaking in it singing or introducing of the tones of an instrument in tube *a-b*, in consequence of the condensation and rarefaction of the air present in this tube, a movement is called forth corresponding with this condensation and rarefaction of the membrane, which closes the tube on its narrowest part.

Lever *c* follows the motions of the membrane, and opens and closes the circuit in d. g. that at each condensation of the air in the tube there follows an opening, and at each rarefaction a closing of the galvanic circuit chain.

In consequence of this process, the electro-magnet of apparatus fig. 4 B gets demagnetized and magnetized proportional to the condensation and rarefaction of the mass of air in the tube, apparatus, fig. 4 A, *a-b*, and the armature belonging to the magnets put in the same vibration as the membrane in the sending apparatus. The plate *i*, connected with the armature, however, transfers these same vibrations of the armature on the air which surrounds the apparatus, fig. 4 B, which finally conveys to the ear of the listener these so produced tones.

The question here, consequently, is not a propagation of the tones through the galvanic current, but only a transfer of the tones produced to some other spot so as to cause on this other spot a like motion, producing a like action.

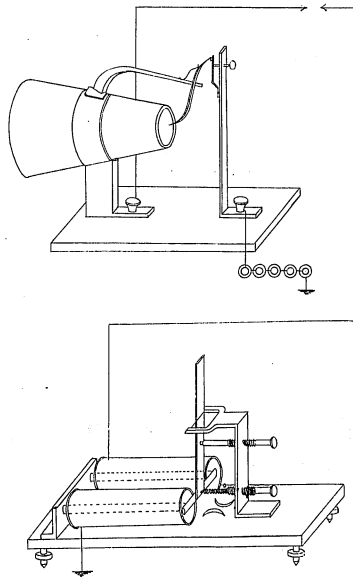
It should be observed, however, that the apparatus in question, in fact, reproduces the same amount of vibrations produced, but that it does not reach equal intensity of the vibrations reproduced, and its productions is probably reserved to the time when the apparatus shall be perfected.

A result of this existing imperfection of the apparatus is, that the less important differences of the original vibrations are more difficult to hear, that means, that the vocal sounds more or less indistinct, the more because each tone remains dependent on the number of the vibrations of the medium, but also on its condensation and rarefaction.

This also explains why, in the practical experiments made—in fact, accords, melodies, &c.—are transferred with astonishing correctness, whereas single words, in singing, speaking, and so forth, could be noticed less distinctly, notwithstanding singing, astonishing and speaking evidence.

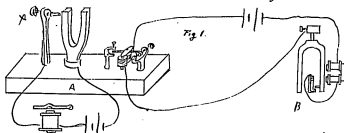
Undoubtedly, the matter discussed here, before attaining a practical form, will need considerable perfection, especially the mechanism of the apparatus which is

to be used. Still, I am persuaded, after repeated practical experiments, that the following up of this matter will prove to be of the highest theoretical interest, and its practical realization in this intelligent age will not be long delayed.



- Acoustic Telegraph -

We had two new tuning forks arranged thus. We tried A & B together but found we could not get A to respond although the vibrations came clearly on the magnet beside the rigid screw X upon the long upright dampened the fork badly.



We now had it altered thus: - Fig. 2 but still could not get them to work.



2. We disconnected magnet of B but kept contact broken in circuit with magnet A. By clicking it we sometimes got a correspondence but not often.

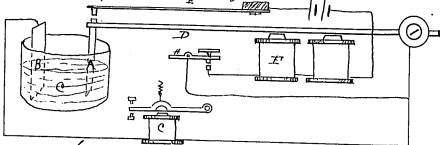
It then occurred that the fork of B made a double vibration, the prongs vibrating in the regular way and the whole fork beside the thin shank screwed into the wood support giving by the power of the magnet produced a false vibration. & gave no results when held over a column of air of any length. To prevent this vibration the support should be metal. The whole apparatus mounted on metal with the poles of the electro magnet placed on both sides of the forks so as

to balance this effect & give equal amplitude of vibration to both prongs.

It is probable that the magnet grasps one prong & compels it to return before it has made the full swing, hence the other prong will not be in sympathy with it and it is also probable that as the movement of one prong is made defective the other should be made equally so to obtain proper results so we shall make magnets to have one pole on each prong of the fork.

Nov. 30th 1875. *Chas Batchelor*

Depolarization of Batteries



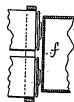
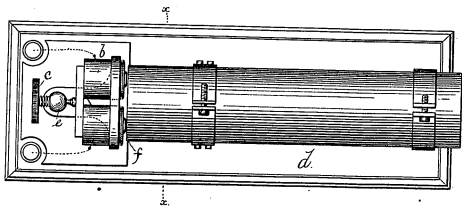
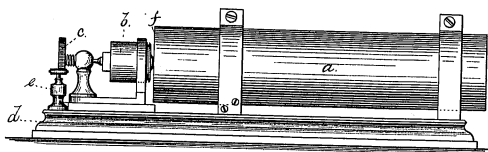
We made this apparatus. A. is a platinum electrode fastened to a vibrating arm of the vibrating mechanism E. D. F. B. is a zinc electrode and forms part of the battery of which A. is the other pole.

The solution is placed in G and the sounder C closes, as the battery polarizes. The sounder opens and we want to find a solution that will close the sounder C quickest after the key H is depressed and the vibrating arm started. Desquignade of Iron & chloride of ammonia closes after a few seconds. Sulphuret of sodium, chloride of ammonia & chloride of mercury closes after a few seconds. Chloride of ammonia & Ferridcyanide of Potassium closes very quick.

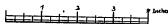
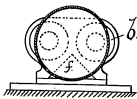
Nov. 17. 1875

Chas Batchelor
James Adams

Edison's Exhibit A. November 1875.



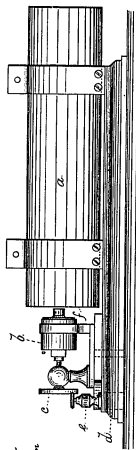
Section at x. x.



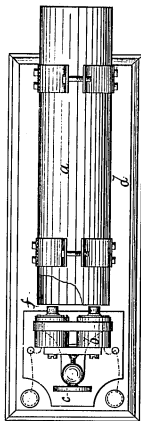
- a. brass tube*
- b. electro magnet*
- c. adjusting screw*
- d. wooden base*
- e. binding posts*
- f. iron diaphragm*

Edison's Exhibit A. 1. Boston 1875.

a. brass tube
b. electro-magnet
c. adjusting screw
d. wooden base
e. binding screw
f. iron diaphragm



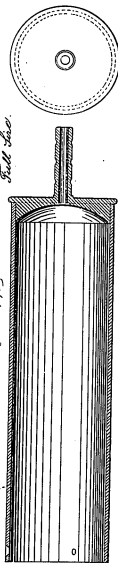
(From page 17)



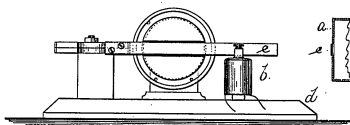
(Recd. page 103)

Edison's Carbonized Tube. A. 3.
(See 175) Full Sec.

Brass

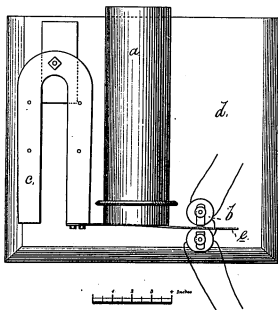


Edison's Exhibit. B. Nov. 1875.



- a. brass tube*
- b. electro magnet*
- c. horse shoe magnet*
- d. wood base*
- e. polarized tongue*

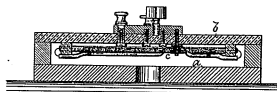
(Record page 28)



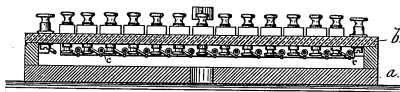
Edison's Exhibit.

Carbon Rheostat.

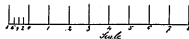
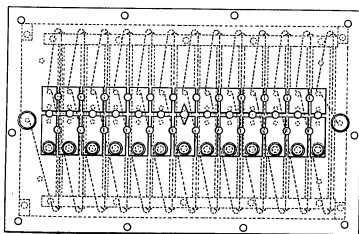
(Constructed in 1873)



a. brass
b. hard rubber
c. glass tubes
containing carbon



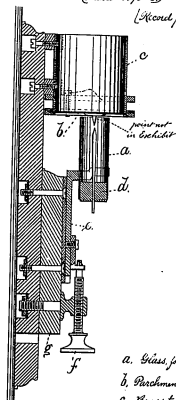
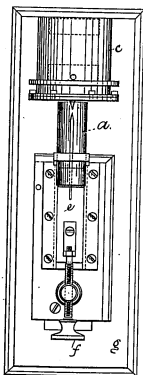
(Record page 46)



Edison's Exhibit.
Water Telephone Instrument

(Made 1878-9)

[Record page 125]

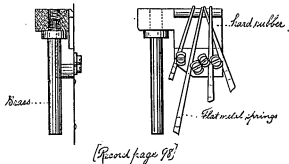


- a. Glass prism
- b. Parchment diaphragm
- c. Brass tube
- d. Cork
- e. Brass slide
- f. Adjusting screw
- g. Wood base

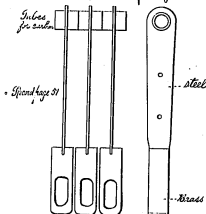
Edison's Exhibit Instrument.

10-11. Feb. 11. 1877.

Full Size.



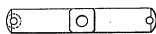
"Edison's Exhibit Springs 42-11."



Edison's Exhibit Instru-
ment 28-11.

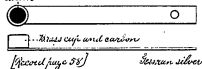


Full Size.
[Record page 101]



(March 1877)

"Edison's Exhibit Spring March 1877."

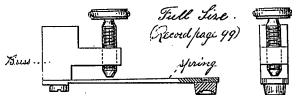


"Edison's Exhibit Cup and Carbon 112-11."



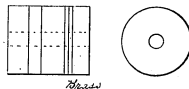
[Record page 53]

Edison's Exhibit Instrument 100-11.



(made before May 25. 1877)

"Edison's Exhibit-Weights 112-11."



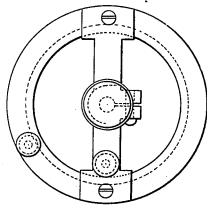
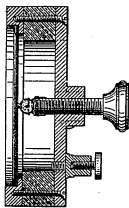
(made about May 31. 1877)

[Record page 53]

Edison's Musical Telephone.

September 1877.

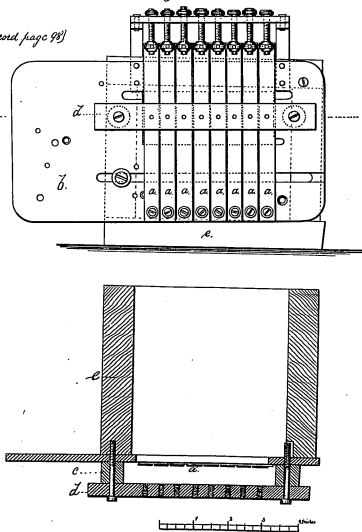
Full Size.



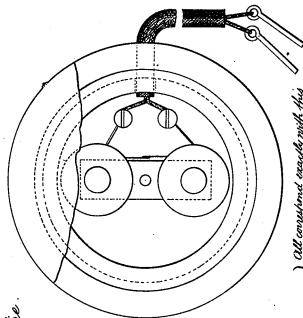
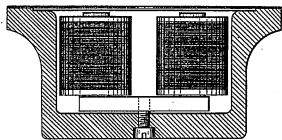
Edison's Exhibit Instrument 14-11.
February 17, 1877.

(Revised page 98)

- a. Thin sheet brass
- b. Brass
- c. Brass
- d. Hard rubber
- e. Wood.



Edison's Exhibit.
Loose Diaphragm.
Sept. 1877.
Full Size.

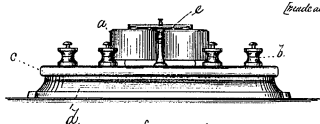


Wiley's Exhibit - Edison's Receiver N° 13.
"Bacchi's Exhibit - Edison's Magnetic Receiver N° 17.
"Bacchi's Exhibit - Edison's Magnetic Receiver N° 18.

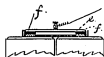
All correspond exactly with this drawing, with the exception that there is no hole in the centre of the diaphragm of the three latter instruments.

Exhibit, Edison's Telephone Relay, - 58-11.

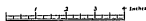
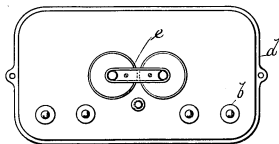
(Made about May 1877)



- a. Electro magnet
- b. Binding posts
- c. Wood
- d. Screw
- e. Armature
- f. Carbon

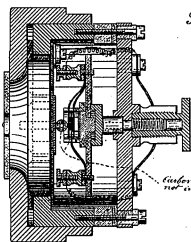


(Record page 98)

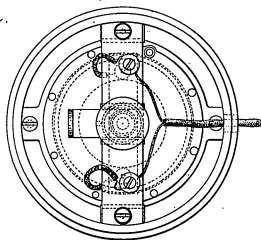


Edison's Exhibit
Three Spring Electrodes.
October 1877.

Full Size.

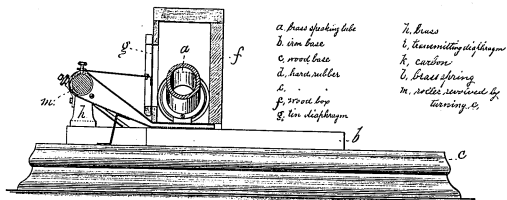


Carbons & Roller
not in place.

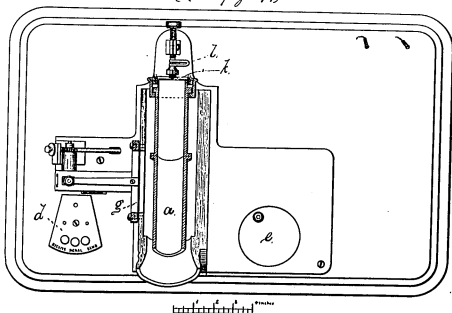


Edison's Exhibit Instrument 130-11.

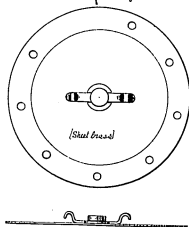
(May 1877)



[Refer page 99]

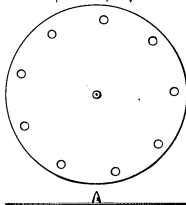


"Edison's Diaphragm 163-12."



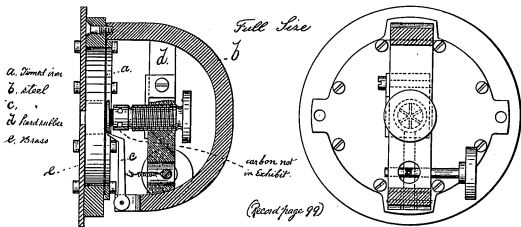
(Rec'd page 55)

"Edison's Exhibit Diaphragm 17-13"

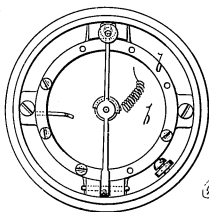


shut iron
(Rec'd page 58)

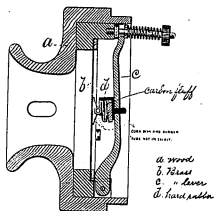
Edison's Exhibit Instrument 23-13, Oct. 17, 1877.



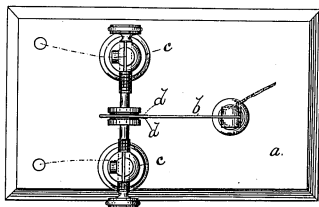
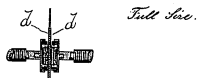
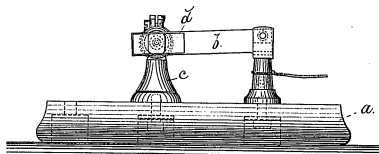
Edison's Exhibit Instrument, 36-13.
Sept. 22, 1877.



(Revised Page 102)



Edisons Exhibit Instrument 67-13. Nov. 5. 1877.

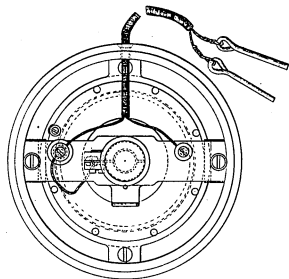


(Rever page 100)

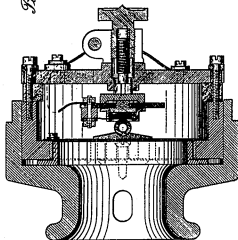


a. Wood
b. Brass
c.
d. platinum foil

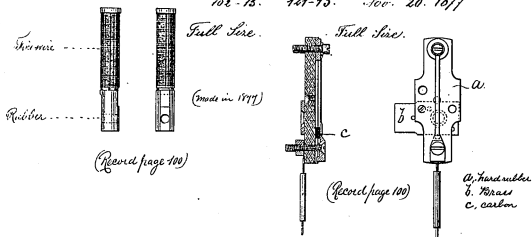
Edison's Articulating Transmitter
Oct. 1878.



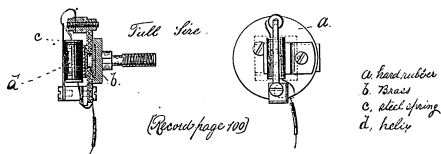
Full Size.



Edison's Exhibit Instrument
102-13. 121-13. Nov. 20. 1877



Edison's Exhibit Instrument. 112-13. Nov. 16. 1877.

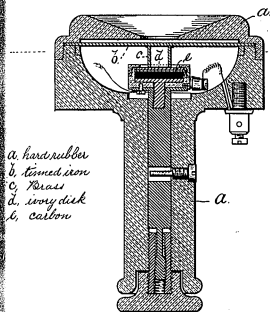


Edison's Exhibit Instrument. Weighted Electrode

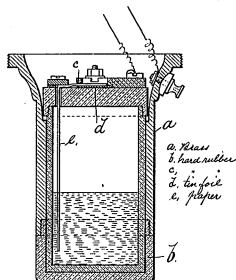


Edison's Exhibit Instrument
119-13 Nov. 26th 1877.

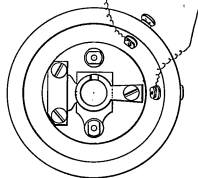
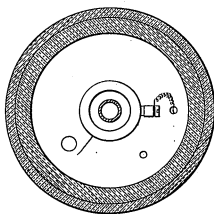
Edison's Exhibit Instrument
119-13 Nov. 19th 1877.



(Revised page 101)

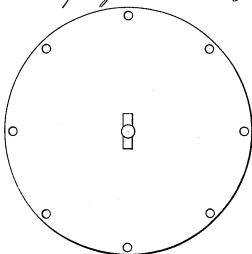


(Revised page 101)



Edison's Exhibit. Iron Diaphragm and Spring.

Full Size.

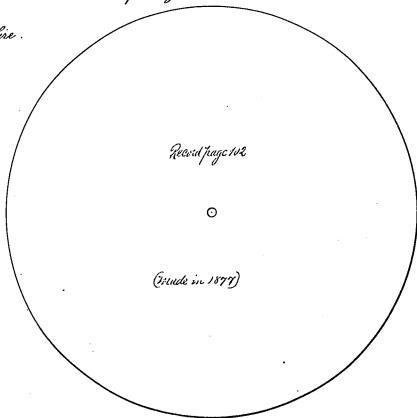


(made April 1877)

(Revd page 162)

Edison's Exhibit. Iron Diaphragm.

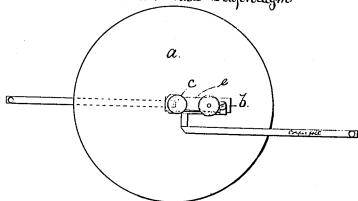
Full Size.



(Revd page 162)

(made in 1877)

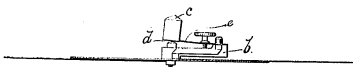
"Edison's Exhibit-Mica Diaphragm"



a, mica
b, hard rubber
c, weight
d, carbon
e, german silver

(Record page 98)

(June 1899)



"Murray's Exhibit
Edison's Plug Holder"

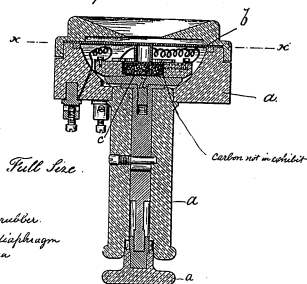


Full Size

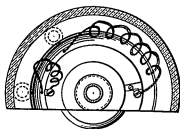
(Oct. 1899)

(Record page 561)

*"Bentley's Exhibit" Edison's Carbon
Telephone. s.º 1.*



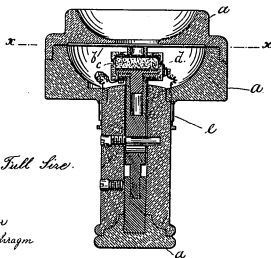
- a. hard rubber.
b. metal diaphragm
c. platinum
d. brass*



(Record page 228)

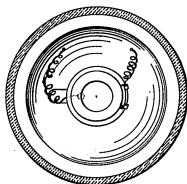
(made about Nov. 1877, record page 245)

*"Bentley's Exhibit" Edison's Carbon
Telephone March 25th 1878.
J^o 2.*



Full Size.

- a. hard rubber*
- b. iron diaphragm*
- c. carbon*
- d. platinum*
- e. brass*



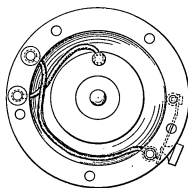
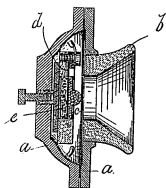
Section at x. x.

(Revised page 323)

(Made about Nov. 1877, second page 545)

Bentley's Exhibit n^o 3.

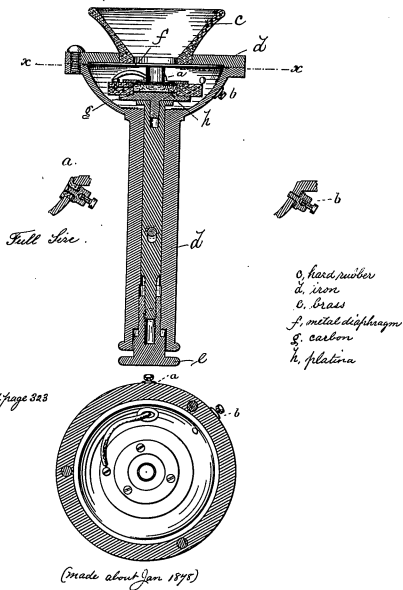
Full Size.



- a. iron*
- b. hard rubber*
- c. metal diaphragm*
- d. platinum*
- e. Carbon*

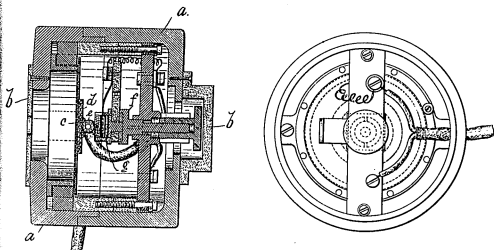
(Refer page 523)

Bentley's Exhibit No 4.



*"Wiley's Exhibit" Edisons Carbon
Telephone. No 16.*

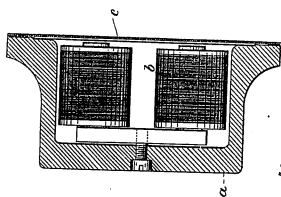
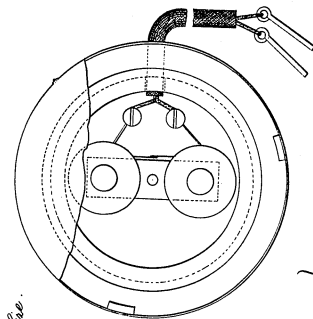
Full Size



- a. wood*
- b. hard rubber*
- c. mica diaphragm*
- d. cork*
- e. soft rubber*
- f. brass*
- g. carbon fluff*

(made about Oct. 15, 1877)

(Reproduced page 537)



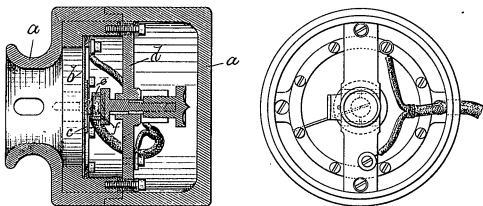
Full size.

"May 14 Exhibit - Edison's Receiver n° 13"
"Pencil Exhibit - Edison's Magnetic Receiver n° 17"
"Pencil Exhibit - Edison's Magnetic Receiver n° 18"

a. wood.
b. electro magnet.
c. iron cylinder.

*"Pescotti Exhibit" Edison's Carbon
Transmitter. N^o. 10.*

Full Size

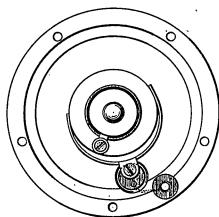
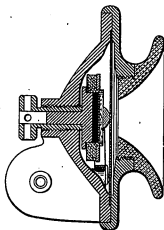


*"Pescotti Exhibit" Edison Carbon Transmitter
N^o 3 is exactly like N^o 10.*

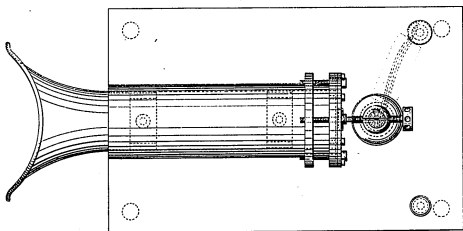
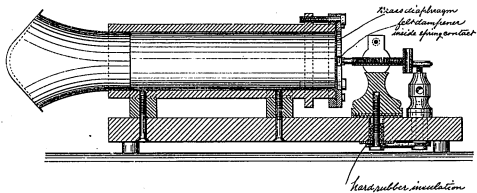
- a. wood
- b. mica diaphragm
- c. cork
- d. brass
- e. hard rubber
- f. carbon fluff

(Refer page 351)

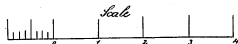
Exhibit Edison's Carbon Telephone.



"Rescotts Exhibit" Edison Transmitter
Brass Tube with mouth piece and Iron Base.

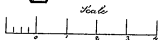
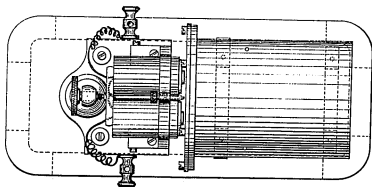
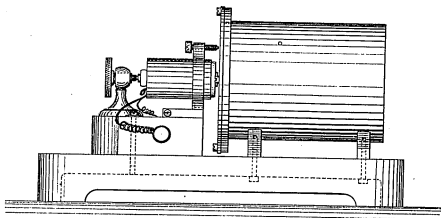


(Record page 552)



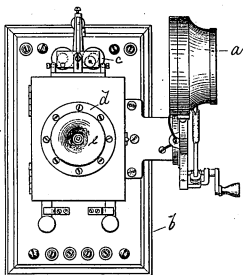
(made in 1897)

*"Rescotts Exhibit" Edison's Iron Trough Magn.
Receiver with Iron Base and Electro-Magnet.*



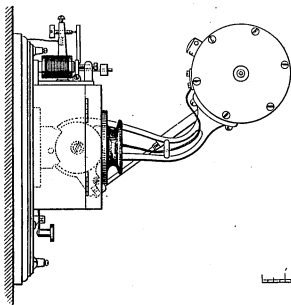
(made in 1878)

(Record page 552)

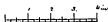


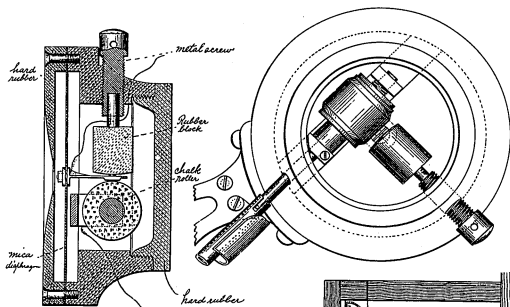
a, hard rubber
b, wood
c, magnet
d, iron
e, hard rubber

Edison's Exhibit
Phonograph



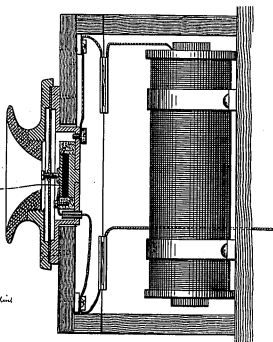
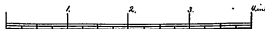
(Record page 99)





*Edison's Exhibit
Mikrophone.*

(Record page 99)



DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all Persons to whom these Presents shall come, Greeting :

This is to certify that the annexed is a true copy from the files of this office of the Pile Wrapper Contents and Drawing, in the matter of the caveat of Thomas A. Edison, Assor. to Western Union Telegraph Company, filed December 2, 1875, for Acoustic Telegraph Apparatus.

In testimony whereof, I, E. M. Marble, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twenty-fourth day of November, in the year of our Lord one thousand eight hundred and eighty , and of the Independence of the United States the one hundred and fifth.

E. M. MARBLE,
Commissioner.

New York, December 1, 1875.

Hon. Commr. of Patents.

Sir:—Inclosed herewith I send check for twenty-five dollars, fees on the application for patent for Wheeler & Jerome Paper Box Machinery, and the caveat of Thomas A. Edison, No. 71 Acoustic Telegraphs.

Resp. yours,

LEMUEL W. SERRELL,
per C. H. Smith.

\$10 Chk.

Caveat No. 71.

To the Honorable Commissioner of Patents of the United States:

The petition of Thomas A. Edison, of Newark, in the county of Essex and State of New Jersey, respectfully represents:

That your petitioner has invented a certain new and useful improvement in Acoustic Telegraph Apparatus, and that he is now engaged in making experiments for the purpose of perfecting the same preparatory to his application for Letters Patent therefor.

He therefore prays that the annexed description of his said invention may be filed as a caveat in the confidential archives of the Patent Office, agreeably to the act of Congress in that case made and provided, he having paid ten dollars into the Treasury of the United States, and otherwise complied with the requirements of the said act.

Respectfully yours,

THOMAS A. EDISON,
Care of Box 4080, New York.

New York, N. Y., Nov. 22d, 1875.

UNITED STATES OF AMERICA. }
City, County and State of New York. }

On this 22d day of November, in the year one thousand eight hundred

and seventy-five, before the subscriber, a Notary Public in and for said State, personally appeared the within named Thomas A. Edison and made solemn oath that he verily believes himself to be the original and first inventor of the within described imp[rovement] in Acoustic Telegraph Apparatus, and that he does not know and does not believe that the same was ever before known or used; and that he is a citizen of the United States.

THOMAS A. EDISON.

Sworn before me the day and year above written.

[L. S.]

CHAS. H. SUMM
Notary Public,
Kings Co.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Newark, in the county of Essex, and State of New Jersey, have invented an improvement in Acoustic Telegraph Apparatus, of which the following is a specification:

The object of this invention is to transmit and receive several different messages over a single circuit at the same time without interference with each other.

The invention consists in transmitting waves of electricity into a circuit by means of "cut outs," operated by spring pendulums the primary motion of which is received by a jar or vibration from an electro-magnet or other source of power.

It further consists in devices for throwing the battery in and out of the circuit without interrupting its continuity.

It further consists in arranging an number of spring pendulums, set in motion by a mechanical device, operated by the finger or an electro-magnet, which pendulums are of different lengths and make a different number of vibrations in a given time, and arranging a main battery with the contact that pendulum No. 1 will at each vibration throw a main battery of say 20 cells in the circuit, a given number of times in one second.

While pendulum No. 2 will also throw in and out of circuit a main battery of a different number of times per second, always preserving the continuity of the circuit.

It further consists in combining with the spring pendulum another spring pendulum of equal length, or of such a length and thickness that it will make the same number of vibrations in a second; this second spring pendulum being used for the purpose of contacts; were the pendulum used for contact purposes longer or shorter, and made a greater or less number of vibrations in a second than the primary pendulum, it would act as a chaper and prevent it from vibrating, if not altogether, at least to a great extent.

The invention further consists in placing at the receiving in conjunction with ordinary Morse apparatus, placed on resonant or sounding boxes, or pendulums, at different vibrating times, each of which has a number of spring transmitting station, making an equal number of vibrations.

These pendulums, unlike the vibrating strings used by Elisha Gray, of Chicago, have no connection with the vibrating strings used by Elisha Gray, of Chicago, placed upon a sounding board with the receiving magnet, other than they are placed upon a sounding board with the electro-magnets.

They are set in motion by jars or vibrations, given such board by the lever of the magnet, and not by the magnetic power of the magnet acting upon the spring, as with Gray.

By using the vibrations transmitted through the resonant box, and by preserving the continuity of the circuit and transmitting the vibrations by various battery powers, I am enabled to transmit a greater number of messages over a single circuit at once than is possible with the devices of Gray, who uses a single battery power, and severs the continuity of the circuit.

The invention further consists in combining double isochronous contact springs on each side of the vibrating spring pendulum at the receiving station, so that the local circuit is closed on both sides of the movement of the pendulum from a state of rest.

It further consists in the manner of connecting the transmitting and receiving instruments and battery at each station, whereby the battery at such station may have the same polarity as the other stations, and be thrown in and out without breaking the circuit; also, in placing each receiving instrument in a derived circuit from the main line by the use of resistance coils, and shunting the coil forming the derivation with a condenser, the object of which is to produce a sharpness in the waves of current which, on long lines, would be apt to run together and produce a constant closing of the circuit without any breaks.

In figs. 1 and 2 are shown the transmitting instruments; both are alike, except that the spring pendulum 2 in fig. 1 is longer and beats a lesser number of times than the pendulum 2' in fig. 2.

The pendulum is secured to the lever of the sounder magnet A, which is operated by a local battery L B and key K.

This lever R strikes upon the pillar 4, and has an upper limiting screw 6; also a retractile spring 8.

5 is a pillar to which is secured the isochronously vibrating contact spring 7, which rests against the contact limiting screw 9, when in a state of rest placing the battery in circuit.

If now the key K be closed, the magnet A will attract the armature and lever R, and it, striking upon the pillar 4, will set the pendulum 2 vibrating, thus striking 7, will also set that vibrating, disengaging it from the battery at 9, and still preserving the continuity of the circuit through 2 and 7, which are in contact when 7 is separated from 9; these waves going over the wire give a vibratory movement to the lever of B, fig. 3, which has little or no play, and the lever 2 striking against the resonant bridge 13, sets the pendulum 13 vibrating, and, being adjusted, make the same number of vibrations per second as 2; in fig. 1 it will continue to vibrate as long as 2 is kept vibrating.

c c are two isochronously vibrating contact springs connected to the sounder 15 and local battery L B, and are so connected to the pendulum 13 that it touches neither when in a state of rest.

The apparatus shown in fig. 4 is the same as in fig. 3, except its pendulum vibrates a greater number of times per second, and is adjusted to 2' of fig. 2.

In figure 5 is shown a larger view of the receiving instrument.

In fig. 6 is shown the method of connecting the receiving and transmitting instruments at end and way stations.

At station A are two instruments.

1 is for transmitting, serving to cut the battery in and out of circuit while preserving its continuity in the manner already described.

2 is the receiving instrument which serves to receive the vibrations from another station. The magnet of 2 is placed in a derived circuit from the line. A resistance 10 is made to form part of the main circuit; R is a second resistance, forming part of the derived circuit in which the magnet of 2 is placed. This resistance is shunted by a condenser for the purpose already mentioned.

At fig. B, where W is a way station, 3 and 4 are receiving and transmitting instruments, connected precisely as at station A.

Any number of stations may be thus connected in the line, and several instruments like 3 and 4 may be placed at each station.

If it is desired to work a second circuit from any part of the line, the sounder of 3 may be combined with devices like that on 4, and a second wire being connected to it, the message may be transmitted upon that line, or, the sounder 0, of 3, may have an ordinary repeating points, and open and close the circuit in the ordinary manner, or the magnets of 3 and 4 may form part of a common automatic repeater, or the sounder of 3 may be a duplex or quadruplex transmitting sounder, and that of 4 the receiving sounder of a duplex or quadruplex.

In fig. 7 is shown devices by which the pulsations from 1 and 2 may be transmitted over the line wire without affecting the receiving instruments 3 and 4.

Nos. 1 and 3 are two transmitting instruments, with spring pendulums, making a different set of vibrations per second, each of which cut in and out of circuit the main batteries M P M P.

S is a switch for cutting out 1 and 2, and connecting the main wire with the earth through a resistance coil R' for the purpose of equating or balancing the circuit.

R and R' are the two sides of a Wheatstone bridge; 25 is the bridge wire in which is placed the two receiving instruments 3 and 4. R' is a resistance forming part of the bridge wire, and is shunted with a condenser resistance of the line and distant apparatus. R' is a resistance equal to the

R is a resistance connected to the condenser C, which is for the purpose of balancing the static charge of the line, the resistance being used to lengthen or shorten the charge from C. When R' condenser C, R and R' are properly balanced, the circuit from M P M P pass over the line and move the distant instruments without passing through 3 and 4, of course the number or sets of vibrations which can be increased with the number of transmitting and receiving instruments can be increased with the number of sets of vibrations which can be practically sent over the wire.

The connections at the distant station are the same as here shown. If it is desired to re-transmit into a second circuit at the distant station, the sounder of the receiving instruments are made to actuate another set of vibrating pendulums like as in 1 and 2.

I do not wish to confine myself to any particular form of vibrating pendulum as a tuning fork or string secured at both ends, or wind instrument may be used.

What I shall probably claim is:

First. The combination of a number of vibrating pendulums, each making a greater or less number of vibrations in a given time than the others with contact devices and separate batteries, so that each shall by its vibration place in and withdraw from circuit its own battery without breaking the continuity of the same.

Second. Communicating a vibratory motion to a vibrating spring pendulum mechanically by the movement of the lever of electro magnets, or otherwise, both in the transmitting and receiving instruments.

Third. In combination with the spring pendulums of isochronously vibrating contact springs for the purposes set forth.

Fourth. The double springs *c c* for the purpose set forth.

Fifth. The combination of an electro magnet with a vibrating spring pendulum, tuning fork or other isochronously vibrating mechanism upon a resonant box or device, and communicating a motion to the latter by jara of vibrating, each having no electrical connection with one another.

Sixth. The method shown for producing sharpness and the vibrations, by placing the receiving instrument in a derived circuit and resistance, and shunting the same with a condenser.

Seventh. The method described for repeating into side levers at way stations.

Eighth. The method shown for transmitting vibrations upon the line from station A, without passing through the receiving instrument at that station.

Signal by me this 23d day of November, A. D. 1873.

THOS. A. EDISON.

Geo. T. Plinkney, } Witnesses.
Clas. H. Smith, }

CAVEAT NOTICE.

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., Feb'y 5th, 1876.

Sir:

You are hereby notified that application has been made to this office for Letters Patent for Impts. in Harmonic Telegraphs with which the invention described, 1st, probable claim in your caveat, filed on the 2d day of December, 1873, apparently interferes, and that said application has been deposited in the confidential archives of the office under provisions of section 4,082 of the Revised Statutes of the United States, which section reads as follows:

SECTION 4302. Any citizen of the United States who makes any new invention or discovery, and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof, and of its distinguishing characteristics, and paying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the office and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other person for a patent with which such caveat could in any manner interfere, the Commissioner shall deposit the description, specification, drawings and model of such application in like manner in the confidential archives of the office, and give notice thereof, by mail, to the person by whom the caveat was filed. If such person desires to avail himself of his caveat he shall file his description, specification, drawings and model within three months from the time of placing the notice in the post office in Washington, with the usual time required for transmitting it to the inventor added thereto; which time shall be indorsed on the notice. An alien shall have the privilege herein granted if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, four days additional, however, being allowed for the transmission of this notice to your place of residence.

Very respectfully,

R. H. DUELL,
Commissioner.
Per WILBER, EXT.

T. A. EDISON,
Care P. O. Box 4,680,
New York City.

71. 43.
1873.
CAVEAT.

No. —.

THOMAS A. EDISON

Assor. to Western Union Telegraph Company.

Of Newark.
County of Essex.
State of New Jersey.

ACOUSTIC TELEGRAPH APPARATUS.

Rec'd.....	Dec. 2, 1873.
Petition.....	" " "
Affidavit.....	" " "
Specification.....	" " "
Drawing two sheets within.....	" " "
Model.....	
Cert. dep.	
1. Cash, \$10, Dec. 2, 1873.	
2.	
3.	
Care P. O. Box 4,680,	

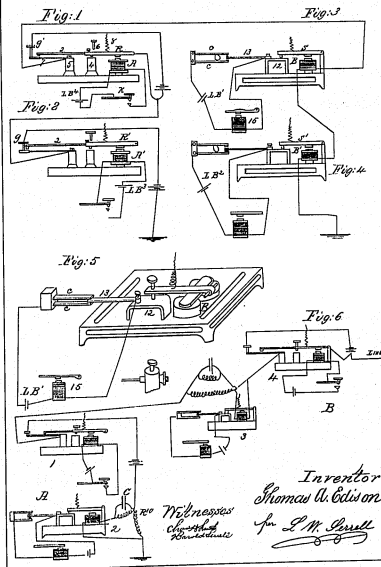
New York City.

1. Notice to complete, Feb. 24th, 1873.

25 Sheets, Sheet 1.
T. A. Edison,

Current 71

Filed Dec. 2, 1876.

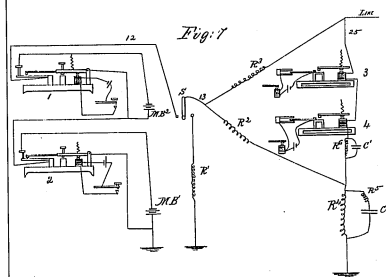


Inventor
Thomas A. Edison
Witnesses
Charles
Edison
for L. M. Bull

T. A. Edison, ^{35 Sheet, Sheet 2}

Created 71.

Filed Dec. 2, 1875.



Witnesses
Charles Smith
David Smith

Inventor:
Thomas A. Edison.
per L. W. Sewell

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all persons to whom these Presents shall come, Greeting :

This is to certify, that the annexed is a true copy from the files of this office of the Pile Wrapper contents and drawing, in the matter of the Caveat of Thomas A. Edison, Assor to Western Union Telegraph Company, filed January 14, 1876, for Multiplex Telegraphs.

In testimony whereof, I, E. M. MARBLE, Commissioner of Patents, have caused the Seal of the Patent Office to be hereunto affixed this second day of February, in the year of our Lord, one thousand eight hundred and eighty-one, and of the Independence of the United States the one hundred and fifth.

E. M. MARBLE,
Commissioner.

(Case No. 724.)

To the Honorable Commissioner of Patents of the United States :

The petition of Thomas A. Edison of Newark, in the County of Essex and State of New Jersey, respectfully represents,

That your petitioner has invented a certain new and useful improvement in Multiplex Telegraphs, and that he is now engaged in making experiments for the purpose of perfecting the same preparatory to an application for Letters Patent therefor.

He therefore prays that the annexed description of his said invention may be filed as a Caveat in the confidential archives of the Patent Office, agreeably to the Act of Congress in that case made and provided : he having paid ten dollars into the Treasury of the United States, and otherwise complied with the requirements of the said Act.

Respectfully yours,
THOMAS A. EDISON.

New York, January 13, 1876.

UNITED STATES OF AMERICA.

City, County and State of New York :

On this thirteenth day of January, in the year one thousand eight hundred and seventy-six, before the undersigned, a Notary Public in and for said State, personally appeared the within named Thomas A. Edison and made solemn oath that he verily believes himself to be the original and first inventor of the within described improvement in Multiplex Telegraphs and that he does not know and does not believe that the same was ever before known or used ; and that he is a citizen of the United States, and a resident of Newark, N. J.

THOMAS A. EDISON.

Sworn before me, the day and year above written.

H. M. HAIGH, (60),
Notary Public,
N. Y. Co.

[L. S.]

To all whom it may concern :

Be it known that I Thomas A. EDISON of Newark, in the County of Essex and State of New Jersey, have invented a certain Improvement in Multiplex Telegraphs and the following is declared to be a description of the same.

The object of this invention is to transmit several messages over a single wire at the same time without interfering with each other.

The invention consists in the various devices employed in transmitting and receiving the signals, all based upon the transmission of several series of vibrations or electric waves, each series having a different number per second.

Fig. 1, shows a double reed, receiving instrument, M, is an electro magnet placed either in the main telegraphic circuit and serving to give motion to the reed *h*, by direct current or arranged with its prongs or poles at each side of the reed and actuating the magnet by induction currents in the manner described in a previous Patent relating to this subject.

c is another reed which is secured to the right iron block *R* as, with *h* and is moved by sympathetic vibrations from *h*. *e* is a long piece of platinum which serves to close the local circuit of the sounder *s*, upon the spring *e*, which is provided with a limiting screw *d*, this spring is of sufficient strength to dampen any tendency of the rod to an excessive amplitude of vibration.

The reason why the second reed is used and worked by sympathetic vibrations is because the transmission of several series of currents or waves through the magnet M, tends to cause the reed *h*, to vibrate in different planes and cause it to be a difficult problem to open and close the local circuit while *h*, not having the magnetic power of the magnet due to waves belonging to other system, or reeds has its vibrations in the same plane hence closing and opening the local circuit is more complete.

It is to be understood that when the sounder is to be nominally opened the vibrations are transmitted over the wire and they are made to cease when the sounder is to be closed; though the reverse action may be used with the different arrangement of the reed contact, device and sounder.

In Figure 2, is shown a slight modification of that shown in figure 1, which consists in dispensing with the spring contact points and substituting another reed *k*, tuned to respond to the same number of vibrations as *g*, and *h*.

When the vibrations to which these reeds answer or vibrate are not transmitted over the wire the two reeds *g* and *h* have their platinum points in contact with each other, closing the local circuit and sounder *s*, but when the vibrations to which these reeds correspond are transmitted over the wire other like the prongs of a tuning fork, which the two reeds are intended to self induced currents within the magnet keep it from attracting its lever. If desirable, the reed *h*, may be secured to another standard as in figure 3, separated a very small distance from each other the local circuit is opened, but when the series of waves which set these reeds in motion is transmitted both reeds almost instantly reach an amplitude of vibrations necessary to bring the points in contact and close the local circuit permanently, while the

waves are sent over the wire. I will mention that the electro magnet M, fig. 3, might be placed directly in front of reed *g*, and *h* dispensed with, but I apprehend the result will not be so satisfactory.

In figure 4 is shown a soft iron reed passing through a hollow bobbins of wire R, connected to the secondary wire of the induction coil I the primary of which is connected on the main circuit and is composed of finer wire and a greater number of convolutions than the wire upon the secondary coil.

On both sides of the reed *a*, at its extremity is placed the tongue of a permanently magnetized horse shoe steel magnet P. M. C, is a contact point which serves to open and close the sounder and local circuit.

When the proper series of waves are transmitted over the wire each wave on closing sends say a positive current on to the secondary coil of I, and through the bobbins R, which giving a directive force to the soft iron reed it is attracted to, say the left, and when the main line wave causes a negative current passes through R from the induction coil giving the reed a contrary directive force and deflecting it to the right of the periodic time of the waves and the pendulum or reed are the same it will almost instantly be set in vigorous vibration to cease when the waves cease to pass over the wire.

In figure 5, is shown a magnetic engine with governor to accurately regulate its speed in the manner described in a previous Patent filed by me in relating to this subject. The object for which I use the engine in this case does not require that the shaft (should) revolve with great regularity; moderate regularity is sufficient, in fact the 4th or 6th wheel of a train of gearing provided with a fly revolves with sufficient regularity to serve the purpose.

a and *b* are two wheels half of the circumference of each being inlaid with an insulating substance, and the wheels are so arranged that the insulating substance of one wheel is immediately opposite the metallic or contact surface of the other wheel. These wheels are rapidly rotated by the electric engine. C and *d* are two contact points connected to *a*, and *b*, of the reeds through the keys X and M, the reeds *g* and *h* being both connected to the main battery M B, when both keys are closed and both reeds are vibrating two series of waves are sent out, but not at the same time; while the point *c* is in contact with the metallic portion of the wheel *a*, the reed *h* transmits into the line waves at the rate of 144 per second, while no waves from *g* can pass into the line as *d*, is resting upon the insulating surface of wheel *b*, but immediately afterwards the position of *c* and *d* change *d* passing on the metallic part of the wheel *b*, (*a* and *b* are connected to line), and allowing the reed *g* to transmit waves at the rate of 96 per second.

Now, as the revolutions of the wheels *a* and *b*, is extremely rapid the consequence is the transmission of rapid "beats" composed of different numbers of waves in the same time. The effect on only transmitting one series of waves at a distance is to cause an easy adjustment of the receiving reeds at the distant station, for in this case, they respond to their proper vibrations and vibrate in the same plane, whereas, if both series of waves were permitted to go together the plane of vibration is changed and the adjusting of the local circuit becomes difficult.

I will mention that the adjustment of the points L and k may be such that the magnetic effect on the magnets at the distant station will be the same, the slow vibrating reed making a shorter contact or longer contact as the case may be.

I will also mention that several wheels may be placed upon the shaft of the electric engine, each so divided that the metallic face of one will be opposed to all the insulating faces upon all the other wheels, and several reeds used, each of which transmits a different series of waves.

In figure 6, is shown an arrangement of the recording reeds to prevent their changing their plane of vibration when several series of waves are being transmitted over the wire, each reed has its magnet connected in a derived circuit in such a manner that the reed and contact points X and X break the derivation in which the magnet is placed, if the waves passing over the wire occur just at the moment that the reed touches say X, the magnet is charged by it and attracts the reed away from X, opening the derivation again and falling back on X, and if another wave comes in the right time another movement is given, but will not respond to other series of waves occurring at different times.

In figure 7 is shown a method of recording the waves whose periodic time is that of the vibrating time of the reed *k*. M is an electro-magnet in the main line circuit and which serves to give motion to *k*.

N is a small bulb containing ink, secured in the end of *k* and ending in a small tube through which the ink cannot pass, owing to the small diameter of its hole. P is a metallic drum which serves to carry the paper forward; this drum is positively electrified, while the ink is negatively electrified by a plate glass machine R, or other source of static electrification, and this static electrification serves to draw the ink through the fine hole of the tube of *n*, in fine spray which is deposited in a finely divided line upon the paper upon the drum P. When the reed is at rest a faint straight line is recorded upon the paper, but when the reed is set in motion a greater amount of ink is squirted upon the paper partly by the vibrating movement imparted to *n*, and by the effect of static attraction.

The record of Morse characters would be as in strip *a*.

The lower line showing the dots and dashes as they ought to be and the upper line as they are recorded.

In figure 8 is shown a recording device whereby chemical decomposition is made to serve the purpose. M is the magnet placed in the main line *k*, the reed vibrating up and down, *n* is a metallic recording point, P, is the drum carrying the chemical prepared paper, B the local battery to effect decomposition.

When the reed is at rest the point *n* is not in contact with the paper and makes no mark, but when the reed vibrates the point touches and records on the paper with so great a rapidity that a slight line is formed, the dots record forty words per minute to be practically continuous.

In figure 9 is shown the combination of several reeds, each of which responds to a different set or series of waves all arranged to be actuated by a single magnet and provided with decomposing points grouped together over chemically prepared paper upon a revolving drum.

The different series of waves being transmitted from the sending station by groups of perforations in paper.

The record is shown in strips B.

The record shown in strips C, is that when the ink bulb *n*, fig. 7, is used upon a series of reeds arranged to record roman letters.

In fig. 10, I show another method of recording by ink the reed *k*, serving

to interrupt the primary coil of an induction coil D, whose secondary wire connects one to an ink bulb and the other to the drum carrying the paper.

The extreme point of the ink bulb *e* is not in connection with the paper, the jump of the spark suffices to carry the ink from the bulb to the paper.

I shall probably claim, 1st, the sympathetic reed as shown in fig. 1, wherein one reed vibrates by sympathy and from the same causes the other substantially and for the purposes set forth.

2nd, The methods of operating the local circuit and preventing the change in the plane of vibration of the reeds substantially as shown in figures 2, 3 and 6.

3rd, The method of giving motion to the reed by passing the same through a helix as in fig. 1 substantially and for the purposes set forth.

4th, The transmission of separate series of electric waves, each series having a greater or lesser number in a given time following each other, but not at the same time into and over a telegraphic circuit in substantially the manner described with reference to fig. 5.

5th, The methods of recording Morse characters by vibrating reeds or bars as shown in figures 7, 8 and 10.

6th, The method of recording Roman or other letters shown in fig. 9 by a series of vibrating reeds.

Signed by me this 18th day
of January, 1876.

Witnesses

H. M. HAIGH,
Wm. C. OSTRANDER.

1876.
(No. 73.)
Circuit.

THOMAS A. EDISON.

No. Thomas A. Edison, Assor to Western Union Telegraph Company.

of Newark,
County of Essex,
State of New Jersey.

Multiplex Telegraphs.
Telephonic.

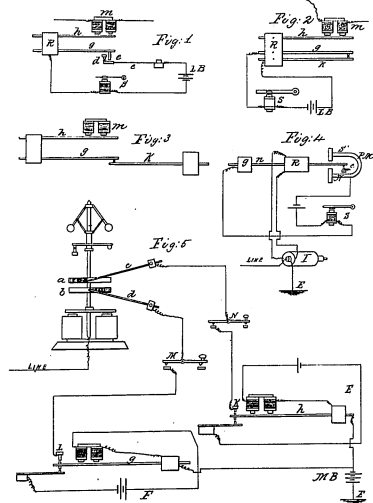
Rec'd	January 14, 1876.
Petition	" " "
Affidavit,	" " "
Specification,	" " "
Drawing 2 sheets,	" Within "
Model,	
Cert. dep.	
Cash \$10.	January 14, 1876.
Circular.	
2,	
3.	

T. A. Edison, 2 Sheets Shaded.

Telephone.

Serial 73

Filed Jan. 14, 1876.

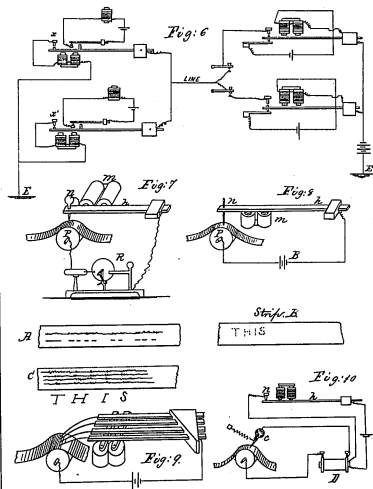


25th Sept. Sheet B.
T. A. Edison,

Telephone.

Car. no. 73

Filed Jan. 14, 1876.



DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting :

This is to certify that the annexed is a true copy from the files of this office of the File Wrapper Contents and Drawing, in the matter of the Caveat of Thomas A. Edison, Assor. to Western Union Telegraph Company, filed January 14th, 1876, for Multiplex Telegraphs.

In testimony whereof, I, E. M. MARBLE, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twenty-fourth day of November, in the year of our Lord one thousand eight hundred and eighty, and of the Independence of the United States the one hundred and fifth.

E. M. MARBLE,
Commissioner.

(Case 74.)

To the Honorable Commissioner of Patents of the United States :

The Petition of THOMAS A. EDISON, of Newark, in the County of Essex, and State of New Jersey, respectfully represents :

That your petitioner has invented a certain new and useful Improvement in Multiplex Telegraphs, and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to his application for Letters Patent therefor.

He therefore prays that the annexed description of his said invention may be filed as a Caveat in the confidential archives of the Patent Office, agreeably to the Act of Congress in that case made and provided ; he having paid ten dollars into the Treasury of the United States, and otherwise complied with the requirements of the said Act.

Respectfully yours,

THOMAS A. EDISON.

New York, January 13, 1876.

UNITED STATES OF AMERICA.

City, County and State of New York :

On this thirteenth day of January, in the year one thousand eight hundred and seventy-six, before the subscriber, a Notary Public, in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within described Improvement in Multiplex Telegraphs, and

that he does not know, and does not believe, that the same was ever before known or used; and that he is a citizen of the United States.

THOMAS A. EDISON.

Sworn before me, the day and)
year above written.

H. M. HANCOCK,

[s. s.] Notary Public,
N. Y. Co.

To all whom it may concern:

Be it known, that I, Thomas A. Edison, of Newark, in the County of Essex, and State of New Jersey, have invented an Improvement in Multiplex Telegraphs, of which the following is a specification:

The object of this invention is to transmit several messages over a single circuit at the same time without interference with each other.

The invention consists in various devices for transmitting over the wire different series of electric waves, which waves, actuating an electro-magnet, or other electrical device at the receiving station, produce different sounds, or more bodies of metal whose vibrating time is at the same rate as the waves coming over the wire.

In fig. 1, is shown two vibrating reeds, a and a' , both set vibrating automatically by double electro-magnet double contact points on either side of the reed, which serve to throw the current from one magnet to the other, as the reed approaches the limit of its oscillation; b and b' are the two points; spring or mercury contacts may replace the rigid points b and b' ; a and a' are the main line contact points.

The reed of R , for instance, touching the point a' , connects the battery m momentarily with the line by the wire z .

While the reed of S does the same thing, but not making the same number of vibrations per second, they jointly do not keep the battery m in connection with the line permanently. I employ electro-magnets with very short cores, say half-inch, and Daniell battery, so that the spark upon the points shall be small.

In fig. 2, is shown a vibrating rocker, tuned to vibrate at a required rate, the temperature which it is necessary to keep the rocker up to, being supplied by a spirit lamp or gas jet; the lever g vibrates against the contact f , serving to connect the battery to the main line in the manner shown in fig. 1, or in any other number, many of which are described in a previous patent upon this subject.

In Figs. 3, and 4, are shown vibrating springs permanently magnetized, operated by electro-magnet through the helix of which reversed current are passed from an induction coil; the primary of which is in the main telegraphic circuit. The primary coil having many convolutions of very fine wire, while the secondary has but few convolutions of large wire.

The vibratory spring, which may either be of such a length that its time of vibration is periodic, with some of the electric waves, or it may be out of time with all them, and be merely vibrated by the power of the electro-magnet. This spring is passed at the mouth of a resonant tube, whose

length may be adjusted by sliding one tube upon the other after the manner of telescope tubes, so that the column of air is of such a length that it will sympathetically vibrate with some of the waves coming over the wire, while the spring d , fig. 4, is vibrated by the cautious waves of current proceeding from the induction coil and acting upon the electro-magnet X , the air in the resonant tube not having a proper length, so as to vibrate to any of the waves the transmission of waves whose period of vibration is the same as the column of air in the resonator, it will be in motion, and that particular rate of vibration or tone will be heard by connecting the rubber tube g to the ear, while all the other series of vibrations will be inaudible, providing the spring strikes against soft pads upon the ends of both projections of the magnet X , or upon the ends of screws which serve to limit amplitude of vibration of the spring.

In fig. 5, is shown a spherical resonator, by which the sound is more powerfully reinforced.

Figs. 7 and 8, show the spherical resonator with vanes placed inside and placed in any position by a wire passing through the resonator, the object of which is to adjust the column of air in the same to cause it to respond to the desired tone.

Fig. 9, shows another form of resonator cut in two parts, which slide over each other.

Fig. 10, shows another resonator, the column of air being adjusted by telescopic tubes at the large nipple of the same.

In Fig. 11, is shown the same arrangement as in figure 4, with the exception of the method of vibrating the reed, and in the manner of receiving the tone, which in this case is made to set in motion a thin steel spring, e , impinging on a local contact point, d .

It is a battery composed of 20 or 30 small high resistance Daniell cells; e is a sounder wound with fine wire, so as to obtain the greatest strength from the battery B .

The reed K has near its extremity a disk i , somewhat smaller than the mouth of the resonator. L is a sliding clasp which serves to cause the reed to give a higher or lower tone.

When no message is transmitted, the vibrations or waves of current continue to pass over the wire and cause the reed K to vibrate, and as the column of air in the resonator is adjusted to vibrate in unison, it sets the spring e vibrating, thereby opening and closing the local circuit a great number of times per second, and owing to the peculiar weakening action of a multiplicity of reversed self-induction currents set up in the helices of the sounder magnet its lever is not attracted; if, now, the operator at the distant station, causes the vibrations, L , e , his set of vibrations to cease, the column of air in the resonator ceases at once to vibrate, notwithstanding the reed K may continue to vibrate by other series of waves, and the spring e also stops and coming immediately in contact with the point d , closes the local circuit until the proper set of vibrations or waves are again transmitted from the other station.

In Fig. 12, is shown a slight modification, the spring being more delicate, and the mouth of the resonator smaller. A pitch disk covering the mouth is secured to the spring.

In Fig. 6, is shown a method of transmitting vibrations by electric en-

gines, which was described briefly in a previous caveat upon Acoustic Telegraphy, filed by me.

T is an electric engine provided with a governor, *c c*; *d* is a collar provided with a flange, *a*, which rises and falls as the balls, *c c*, rise and fall; resting upon the flange (*t*) is a contact rod, *a*, which rests in contact with the circuit closing point, *b*.

L is a local battery, which serves to give motion to the engine. P is a contact point, and R a spring, both of which serve to close and open the circuit at the proper time to cause the engine shaft K to revolve the magnet, *m m*, spring R, point P, battery L, R, lever *a*, and point *b*, are all included in the same circuit.

O is the revolving iron armature secured to the shaft; the shaft is also provided with a fly-wheel (not shown).

When the shaft is rotated, the governor ball spreads out and lifts the collar *d* and flange *c* upwards and then lifts the lever *a* away from *b*, opening the local circuit when the engine slows down, allowing the lever *a* to again touch *b*, and so on; it is obvious that the screw *b* may be raised or lowered, so that the local circuit may be broken at any rate of speed. The effect of the automatic opening and closing of the circuit by the engine itself when it reaches a certain rate of speed, causes it to revolve with remarkable regularity.

Upon the shaft K may be placed several contact wheels for the transmission of waves of electricity from a main battery to the main telegraphic circuit; for convenience in description, I have shown only two wheels, one of which has, say, 12 contact teeth, while the other has 8, hence, for every 2 waves transmitted from the wheel having 8 teeth, 3 waves will be transmitted from the wheel having 12 teeth. If the wheels are connected to the main battery and the contact springs 2 and 3, to the keys S and S', and these waves of current are transmitted over the wire according to the position of the keys, giving the engine a proper rate of speed and always maintaining it. The receivers at the distant station may be turned or adjusted to the different sets of waves.

I do not wish to confine myself to any particular form of break wheel, or to any particular method of throwing the proper waves in and out of the main telegraphic circuit, numerous methods being described in my caveats, almost any of which can be adapted to these wheels.

Neither do I wish to confine myself to an electric engine for rotating the various break wheels as clock work with governors or other sources of power having governors can be used instead.

I shall probably claim:

1st.—The method shown in Fig. 1 for transmitting series of waves of a telegraphic circuit for the purpose set forth.

2d.—The use of a Tremblay-Rocker, operated substantially as described in Fig. 2, for the purpose set forth.

3d.—The adjustable tube resonator in combination with a vibrating spring or other material substance, whether its vibrating time is equal or unequal to the waves of current passing through its magnet for telegraphic purposes.

4th.—The method shown in Fig. 4, of operating the spring *d* by reversed inductive currents, as described.

5th.—The method of adjusting the column of air in the resonators shown in Figs. 4, 7, 8, 9 and 10, for the purpose set forth.

6th.—The sympathetic movement of a circuit closing spring of membranes by the action of a primary vibrating spring, operated by electric currents when the same is accomplished by the use of a column of air in a resonator of any construction, substantially as shown in Fig. 11.

7th.—The modification of the device last claimed, as shown in Fig. 12.

8th.—The combination of a series of contact wheels with a different number of teeth in each upon a shaft rotated by an electric magnet or other regulatable device operated by any source of power, substantially as shown in Fig. 6, and for the purposes specified.

Signed by me this thirteenth day of January, A. D. 1876.

THOMAS A. EDISON.

Witnesses:

H. M. HARRIS,
WM. C. OSTRANDER.

CAVEAT NOTICE.

DEPARTMENT OF THE INTERIOR.

U. S. PATENT OFFICE,

WASHINGTON, D. C., Feb'y 5, 1876

Sir:—You are hereby notified that application has been made to this Office for Letters Patent for Improvement in Telephonic Telegraphs, with which the invention described 8th. probable claim, in your caveat No. 74, filed on the 14th day of January, 1876, apparently interferes, and that said application has been deposited in the confidential archives of the Office, under provisions of Section 4902 of the Revised Statutes of the United States, which section reads as follows:

Section 4902. Any citizen of the United States who makes any new invention or discovery, and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof, and of its distinguishing characteristics, and praying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the Office, and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other person for a patent with which such caveat would in any manner interfere, the Commissioner shall deposit the description, specification, drawings and model of such application in like manner in the confidential archives of the Office, and give notice thereof, by mail, to the person by whom the caveat

was filed. If such person desires to avail himself of his caveat, he shall file his description, specification, drawings, and model within three months from the time of placing the notice in the post office in Washington, with the usual time required for transmitting it to the inventor added thereto; which time shall be imposed on the notice. An alien shall have the privilege herein granted, if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, four days additional, however, being allowed for the transmission of this notice to your place of residence.

Very respectfully,

R. H. DUELL,
Commissioner,
For WILLIAM, Esq.

T. A. EDISON,
New York City.
Sent care Porter, Lowrey, Loren & Stone,
197 Broadway.

NOTICE TO CAVEAT.

DEPARTMENT OF THE INTERIOR,

U. S. PATENT OFFICE.

WASHINGTON, D. C., Feb'y 21, 1876.

Sir:—You are hereby notified that application has been made to this Office for Letters Patent for Local Circuit Breakers for Electric Harmonic Telegraphs, with which the invention described in 5th and 7th possible claims of your caveat, filed on the 14th day of January, 1876, apparently interferes, and that said application has been deposited in the confidential archives of the Office, under provisions of Section 4302 of the Revised Statutes of the United States, which section reads as follows:

Section 4302. Any citizen of the United States, who makes any new invention or discovery, and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof, and of its distinguishing characteristic, and paying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the Office and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other person for a patent with which such caveat would in any manner interfere, the Commissioner shall deposit the description, specification, drawings and model of such application in like manner in the confidential archives of the Office, and give notice thereof, by mail, to the person by whom the caveat was filed. If such person desires to avail himself of his caveat, he shall file his description, specification, drawings and model within three months from the time of placing the notice in the post office in Washington, with the usual time required for transmitting it to the inventor added thereto; which

time shall be endorsed on the notice. An alien shall have the privilege herein granted, if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, four days additional, however, being allowed for the transmission of this notice to your place of residence.

The especial caveat referred to is No. 74 of your series.

Very respectfully,

R. H. DUELL,
Commissioner.

T. A. EDISON,
In care of Porter, Lowrey, Soren & Stone,
197 Broadway, New York City.

N. B.—The especial matter referred to as expressed in the interfering case is the combination "of an electric magnet, vibrating reed, sounding box of corresponding pitch, and a local circuit breaking apparatus, actuated by the vibrations of a column of air in said sounding box."

1876.

(No. 74.)

40

No. C A V E A T.

THOMAS A. EDISON,
Assor. to Western Union Telegraph Company,
Of Newark,
County of Essex,
State of New Jersey.

MULTIPLIX TELEGRAPHS.

Telephonic.

Rec'd	Jan'y 14, ...	1876.
Position	" "	"
Affidavit	" "	"
Specification	" "	"
Drawing 2 sheet	Jan. within 14, ...	"
Model	" "	"
Cost, Dep.	Jan'y 14, ...	"
1. Cash, \$10, ...	" "	"
Circular	" "	"

2.
3.

1 Letter (Notice to complete).

Feb'y 5, 1876.

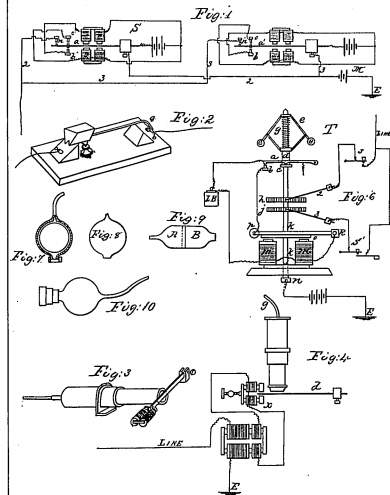
Letter (Notice to complete).

Feb'y 21, 1876.

T. A. Edison 2 Sheets, Sheet 1.

Created 7/4

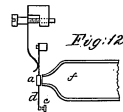
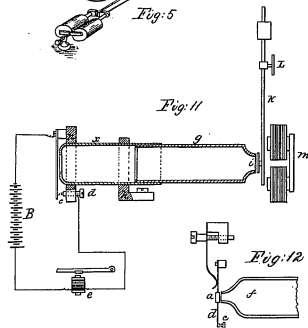
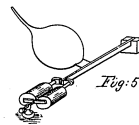
Filed Jan. 14, 1876.



T. A. Edison ^{25 Sheet, Sheet 2}

Carb. 74

Filed Jan. 14, 1876



DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all Persons to whom these Presents shall come, Greeting:

This is to certify, that the annexed is a true copy from the files of this office of the File Wrapper Contents and Drawing in the matter of the Caveat of Thomas A. Edison, Assor to Western Union Telegraph Company, for Acoustic Telegraphs.

In testimony whereof I, W. H. DOOLITTLE, Acting Commissioner of Patents, have caused the Seal of the Patent Office to be hereunto affixed, this twenty-sixth day of April, in the year of our Lord one thousand eight hundred and eighty, and of the Independence of the United States the one hundred and fourth.

[L. s.]

W. H. DOOLITTLE,
Acting Commissioner.

To the Honorable Commissioner of Patents of the United States:

The petition of THOMAS A. EDISON, of Newark, in the County of Essex, and State of New Jersey, respectfully represents:

That your petitioner has invented a certain new and useful improvement in Acoustic Telegraphs (Caveat 75), and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to his application for Letters Patent therefor.

He therefore prays that the annexed description of his said invention may be filed as a Caveat in the confidential archives of the Patent Office, agreeably to the Act of Congress in that case made and provided; he having paid ten dollars into the Treasury of the United States, and otherwise complied with the requirements of the said Act.

Respectfully yours,

THOS. A. EDISON.

New York, January 13th, 1876.

UNITED STATES OF AMERICA.

City County and State of New York:

On this thirteenth day of January, in the year one thousand eight hundred and seventy-six, before the undersigned, a Notary Public in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within described improvement in Acoustic Telegraphs, and that he does not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States.

THOS. A. EDISON.

Sworn before me, the day and year above written.

H. M. HAIGH (90),
Notary Public,
N. Y. Co.

[L. s.]

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Newark, in the State of New Jersey, have invented an Improvement in Acoustic Telegraphs, of which the following is a specification:

The object of this invention is to transmit and receive several messages at the same time over a single wire, without interference with each other.

The invention consists in various devices whereby the battery current may be thrown in and out of a telegraphic circuit by a self-vibrating electro-magnet, in a manner to meet the various conditions found in practical telegraphy.

The invention further consists in various devices for stopping and starting or transmitting combination of waves to effect telegraphic transmission by dots and dashes.

The invention further consists in a method of analyzing several sets of vibrations received upon one or more electro-magnets or other sonner devices by the use of resonators, each of which has its column of air of such a length that it will only respond to a certain series of waves.

The invention further consists in various methods for moving the column of air within the resonator.

The invention further consists in destroying the spark upon the contact points of the self-vibrating reeds or forks, by shunting such points, or the magnet, by a condenser.

The invention further consists in the adaptation of a Torsionless retractor for the transmission of electric waves.

In figure 1 is shown a method for transmitting the different sets of vibrations or waves.

A and B are two electro-magnets which serve to give motion to two reeds, tuning forks or bodies, following the law of the pendulum.

Upon the extremity is secured a platinum contact point, opposite to which is placed a platinum-tipped contact spring, which is so connected that the movement of the reed is made to open and close the current of the electro-reed. C and C' are two right contact points, in contact with the batteries in the main circuit. D and E are two batteries, which serve to transmit the waves of the wire. The current from D is transmitted by the neutralizing battery E, and allows the full current from D to pass over the contact with the point C, short-circuiting the battery G, 200 times per second, and allows F to transmit that many pulsations, or waves, over the wire, and also F and G, preventing the transmission of waves altogether by the action of the reeds while the keys are closed on either the front or back point, but allows the transmission by the reeds of a series of waves, while in contact with neither. The object of this transmitting a short series of waves on closing, and also on opening, is to imitate the action which takes place in a Morse sonner, and thus allow persons who are familiar with Morse sound reading to read from the resonators with equal facility. Upon a Morse sonner a dot is composed of two sounds following each other very

closely; for instance, in making the letter E, which is a single dot, two sounds are necessary, first, that produced by the lever of the magnet striking the lower limiting point, bridge or screw, and the second when the lever raises and comes in contact to the upper limiting point or screw.

In the case of a dash, the two sounds are necessary, but do not occur so close together as with a dot. Upon the downward movement of the lever a sound is produced, and the lever is allowed to rest against this point for a certain length of time, when it raises, and coming in contact with the back point, or screw, produces the second sound.

In the case of the keys K and K', figure 1, upon depressing, say key K', waves of current pass over the wire and are heard in the resonator for an instant only, when they cease, the key lever having touched the front point. This produces the first sound necessary to form a dot, as is the case with the Morse sonner. Now, when the key K' is allowed to rise, another series of waves pass over the line during the interval that the key lever is passing from one point to the other, and this sound heard in the resonator gives the second sound necessary to complete a perfect dot. By thus transmitting the waves, messages can be transmitted in the usual manner and copied with remarkable facility from the resonator, or from the sound produced from the movement of reeds or tuning forks beating isochronously with the transmitting reed, L, is the magnet at the receiving station, 4, is a thin strip or bar of iron, in contact with the cores. The magnet L is placed in one branch of the main circuit, with an adjustable resistance coil R. The other branch has a large electro-magnet placed within the second derivation, the object of which is to transmit inductive currents through the smaller magnet L, to cause it to act quicker. The resistance coil R may be shunted with a condenser, which increases the effect, and even the electro-magnet L may be shunted with another condenser, which will also increase the effect. R is a Helmholtz resonator of a size which allows its column of air inside to be set in motion by the waves from B. S is a second resonator, having a different column of air, which is only set in motion by the waves from A.

In figure 2 is shown another method of throwing batteries in and out of circuit, by devices operated by the vibrating reeds. When the reeds are not in contact with the spring points L, the battery is in the main circuit, but when the reed is drawn forward by the action of the electro-magnet, it separates the spring I from the point C, and disconnects the battery D from the line, at the same time preserving the continuity of the circuit. The same action takes place at A.

The transmitting keys may be made to short-circuit the batteries D and E in the same manner as in fig. 1, or the batteries may be thrown in and out of circuit in the same manner as in the ordinary duplex telegraph.

In figure 3 is shown another method for throwing currents in and out of circuit, and devices for transmitting the waves in a proper manner to produce dots and dashes. A and B are the self-vibrating reeds, the reeds c and c' are the main line contact points, which are connected to a piece of metal inserted in the insulating blocks d and d'; passing over the surface of the block and insulated metal, is the contact spring moved up and down by the electro-magnets e and e', placed in local circuits, each with a local battery and key. The operation is as follows: When the keys K' and K' are open, the lever of the magnets e and e' are in such positions that the point on the

spring rests against the insulating substance of the blocks d and d' , and although the reeds are making contact with the points e and e' , no current is transmitted, but when either key is closed, the magnets e or e' attracts its lever, and an upward motion is given the contact spring which, passing over the insulated metallic block in d or d' , connects the battery to the line for an instant only, as the spring, whether up or down, rests upon the insulating substance and only connects the battery to the line in its passage from one point to the other.

R is a resistance coil, having resistance perhaps four times greater than the internal resistance of the battery. When the reed of, say A , is not in contact with the point e , the continuity of the main circuit is preserved through the coil R , and when contact is made at e , and the spring of C is in contact with the inserted metal of d , the current from battery M B circulates within a short circuit formed by R , wire 12, reed point e , battery M B, d , and spring, but a large portion passes into the longer circuit, or main line formed by the line wire 13, wire 15 and earth L .

The same action takes place with the devices of B .

L is the receiving instrument. R' is a shunt to preserve the continuity of the circuit. R' is a coil of large resistance, shunted with a condenser, the object of which is to compensate for the static charge of the line, and render the waves sharper, and thus give sharp action to the cores of the magnet L .

In figure 4 is shown another device, whereby the proper transmission of the signals can take place without increasing the power of the battery for each series of pulsations, and a device whereby the waves are manipulated similarly to those shown in figures 1, 2 and 3, to insure a proper transmission of the dots and dashes.

A and B are the vibrating reeds. E and F are the electro magnets for transmitting the series of waves in short intervals to produce dots and dashes at the distant station.

The contact springs 2, 3 and 4, shown in fig. 3, are so arranged that when the sounder lever touches 2, the waves of current pass into the line up to a point where the lever has reached the limit of its downward motion, when the spring 3 is separated from the point 3, by the rubber projection from spring 2, when the waves cease. When the lever is allowed to rise the reverse action takes place.

In figure 5 is shown another device for throwing the battery current in and out of circuit, or rather increasing and decreasing the amount of current in the circuit. A and B are the vibrators, the reeds of which short circuit e and e' , thereby increasing and decreasing the current from the main battery signal.

The devices shown in figs. 3 and 4 may be used instead of the keys K' and K'' to effect more perfect signaling.

In fig. 6 is shown another method similar to that shown in fig. 3, except in the manner of sending the short series of pulsations. Extra magnets C short-circuit the make and break of the circuit between the reeds and their contact points e and e' , when the levers of C and D are in contact with either their front or back contacts, but allows the reeds to transmit waves

for that instant of time that it takes the levers to pass from their back to their front contact point.

In fig. 7 is shown another method of transmitting different series of vibrations. A and B are two small electric engines, provided with governors h , arranged with an electrical cut-out, operated by the rise of the governor h . Both engines run at the same speed; upon the shaft of each is placed a contact wheel and springs, the wheel having a certain number of notched teeth, with spaces filled with insulating substance, or the break wheel may be of any character which will serve to give a certain number of contacts at each revolution of the shaft. The break wheel of A has, say 50 contacts, while the wheel on B has 65.

K and K' are keys for controlling the vibrations or waves of current. M B is the main battery. I will mention that the keys might be replaced by the devices shown in figs. 2 and 3, and a single engine could be used, having upon its shaft several break wheels, each of which has a different number of contacts, or we I move a lever to give a different number of contacts. I will also mention that the engine device could replace any of the reed vibrations shown in the previously described methods.

The receiving apparatus shown in fig. 7 is somewhat different from those previously described.

A and B are the receiving instruments, A being adjusted to respond to the vibrations transmitted by the engine A , while B is adjusted to respond to the vibrations sent by the engine B .

C is an electro-magnet (fig. 8), the main line being connected to it on the wire which connects one spool with the other. M is an electro-magnet with its keeper permanently attached to its cores, and is used for inductive purposes. R is a resistance equal to the resistance of the electro-magnet M . C is a delicate vibrating reed, impaling against a contact point, which magnetized permanently, its extreme end being placed between the two poles of the electro-magnet e . If the current is passed over the main line permanently, it divides where it enters e , one half passing through one spool to the resistance coil R to the other instrument, while the other half passes through the other spool and magnet to the next instrument, and as each current, acting in the spool, tends to set up the same kind of magnetism in each iron core, the result is that no magnetism is created in the cores of C , but now if the current be interrupted the cores of the magnet M , discharging within the circuit formed by R and the spools of C , passes through the spools in a direction to make the iron cores magnetic. If now the circuit be closed on a current sent over the wire, a contrary induced current is set up by the magnet M , which magnetizes the cores of C in an opposite direction, hence the reed is made to vibrate back and forward like the tongue of a polarized relay, and as the directive force of the magnetism in the reed may be less than the weakest current passing over the line, it follows that it will always vibrate with a certain strength independent of the strength of the current upon the line. I will mention here that an induction coil might be used with its primary wire of greater resistance and having a greater number of convolutions than the secondary wire, the latter being connected to the magnet C in the usual manner, or the magnet C might be placed in a derivation, so to speak, formed by a condenser of great electrostatic capacity.

In figure 9 is shown a modification.

A is a very short magnet, placed upon one side of the reed, and B a long magnet, placed upon the other side of the reed. The latter magnet is shunted with a resistance coil R, about equal to the resistance of the magnet itself.

At the moment the circuit is closed the cores of the short magnet A become instantly magnetic, but the inductive change from B, having a continuous short circuit in which they can circulate, act to prevent the cores from instantly acquiring their magnetism, hence the reed is attracted by A, yet when the cores of both have acquired their maximum magnetism, the pull on the reed is equal on both sides. Upon opening the circuit the small magnet instantly loses magnetism while the secondary induced current from B circulating through R, delays the demagnetization of the cores of B and this residual magnetism draws the reed to the other side.

In figure 10 is shown another modification. A is the magnet which gives motion to the polarized or magnetized reed by inductive currents, set up within its spoils by the action of the iron cores of B upon those of A, B is placed in the main circuit.

In figure 5 it is shown two iron cores, adjusted to different rates of vibrations, but all set in motion by the electro-magnet X, placed in the main circuit.

C D and E are resonators to pick out the sound produced by the different vibrations. In fig. 11 is shown a softacting vibrator for transmitting definite vibrations over the line wire, or controlling the current thereon.

B is the electro magnet which serves to give motion to the permanently magnetized reed C, playing between the two contact screws, *d* and *e*.

A is an electro magnet which, by its inductive currents, gives motion to the reed through B, by changing the polarity of its cores, in opening and closing the circuit at the point *c*; the operation is as follows:

When the reed C touches *e*, the current is completed by passing through both spoils of B, and the passage of this current sets up an inductive current in A, which in its turn acts upon B, to give it polarity necessary to attract the reed towards *d*, which it touches, but just as it leaves *e* the magnet A discharges an inductive current of the opposite polarity through B, which tends to throw the reed to *e*, and so on.

The contact of the reed with *d* connects the battery wire 5 with the line wire 6.

In fig. 12 is shown a Helmholtz resonator with a membranous strip nearly covering the receiving end; attached to this membrane is a thin reed connected to a thin tube of iron passing within the hollow helix of wire connected to the line wire. When certain vibrations corresponding to the vibrating rate of the air in the resonator, pass over the wire, the movement of the membrane sets the air in motion and a large sound is heard when the air is placed at X.

In fig. 13 is shown a modification, the electro magnet being provided with a flexible armature communicating vibrations to a resonant stand, upon which is secured a resonator made of wood, which, taking up the vibrations, communicate them to a column of air within, and produce the requisite sound.

In fig. 15 is shown a modification. A is an electro magnet connected to

the line wire, the cores of which act upon a delicate steel spring *e*, placed in front of the mouth of two Helmholtz resonators, P and P', both adjusted to sound to the same set of vibrations.

In fig. 16 is shown Helmholtz resonators made of iron and having a coil of wire (connected to the line) wound around them. The magnetization and demagnetization of the iron of the resonators sets its column of air in motion and produces the requisite sound.

Fig. 17 shows a slight modification, in so much as the column of air is in a long iron tube, A, surrounded with the helix connected to the line wire.

In fig. 14 is shown another modification. A and B are two tubes sliding over one another, after the manner of a telescope, so that the columns of air can be so adjusted that it will respond to any given sets of vibrations. In front of the mouth of the same is a thin steel spring, receiving a vibrating motion from an electro magnet placed in the main circuit.

M, chains will probably be:

1st.—The various devices shown in figures 1, 2, 3, 4, 5, 6 and 7, for increasing and decreasing or throwing in and out of the main circuit the battery currents.

2d.—The method described of transmitting dots and dashes by sending short waves composed of many vibrations, two short waves occurring close together to form a dot and two short waves not occurring so close together to form dashes.

3d.—Translating from composite sounds a given sound by means of resonators having columns of air for telegraphic purposes.

4th.—The use of polarized vibrating reeds turning forks or bodies following the laws of the pendulum when the same are set in motion by the action of reverse currents transmitted from a battery or derived from induction substantially as shown in figures 7, 9 and 10.

5th.—The method of automatically vibrating the reed substantially as shown in fig. 11.

6th.—The method shown in figs. 12, 13, 14, 15, 17 and 18, whereby the column of air in a resonator is set in motion for the purpose specified.

Signed by me, this thirteenth day of January, 1875.

THOMAS A. EDISON.

Witnesses:

H. M. HAIGH.

WM. C. OSTRANDER.

DEPARTMENT OF THE INTERIOR,

U. S. PATENT OFFICE,

WASHINGTON, D. C., May 18, 1876.

Sir:—You are hereby notified that application has been made to this Office for Letters Patent for Receivers for Electro Harmonic Telegraphs, with which the invention described in part of your caveat No. 75, filed on the 14th day of January, 1876, apparently interferes, and that said applica-

tion has been deposited in the confidential archives of the Office, under provisions of Section 4902 of the Revised Statutes of the United States, which section reads as follows:

Section 4902. Any citizen of the United States who makes any new invention or discovery, and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof, and of its distinguishing characteristics, and paying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the Office and processed in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other person for a patent with which such caveat would in any manner interfere, the Commissioner shall deposit the description, specification, drawings and model of such application in like manner in the confidential archives of the Office, and give notice thereof, by mail to the person by whom the caveat was filed. If such person desires to avail himself of his caveat he shall file his description, specification, drawings and model, within three months from the time of placing the notice in the post office in Washington, with the usual time required for transmitting it to the examiner added thereto, which time shall be indorsed on the notice. An alien shall have the privilege herein granted, if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, four days additional, however, being allowed for the transmission of this notice to your place of residence.

Very respectfully,

R. H. DUELL,

Commissioner of Patents.

THOMAS A. EDISON,
Newark, N. J.

ADDRESS NOTIFICATION.

TO THOMAS A. EDISON, care Porter, Lowrey, Soren & Stone,
107 Broadway, New York.

N. B.—The portion of the caveat interfering is that shown in Figure 8 the drawings filed therewith, which arrangement of reeds and a single magnet is also used and shown in fig. 9 of Caveat No. 72.

Expressed in the favor of a claim, the interference would be upon "the combination in an electric circuit of an electro magnet, through which notes of a different pitch are transmitted, with two or more vibrating reedling springs, tuned correspondently with the notes transmitted, so that each analyzer or spring selects its own tone from the magnet without interfering with the other."

Z. F. WILBER,
Ex.

1870.

(No. 75.)

CAVEAT.

No.

THOMAS A. EDISON,
Assor. to Western Union Telegraph Company.

Of Newark,
County of Essex,
State of New Jersey.

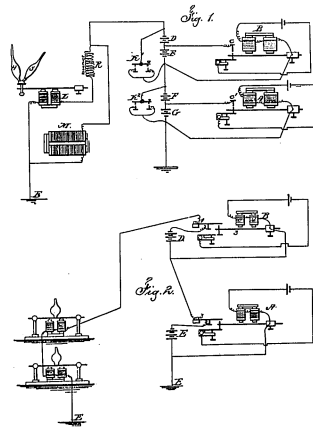
ACOUSTIC TELEGRAPHS.

Rec'd	Jan'y	14.....	1870.
Petition	"	"	"
Affidavit	"	"	"
Specification	"	"	"
Drawing & sheets	"	within	"
Model			
Cert. dep.			
1 Cash, \$10.	Jan'y	"	"
Circular			
2			
3			

T. A. Edison ^{4, Sheet 2, Sheet 11}

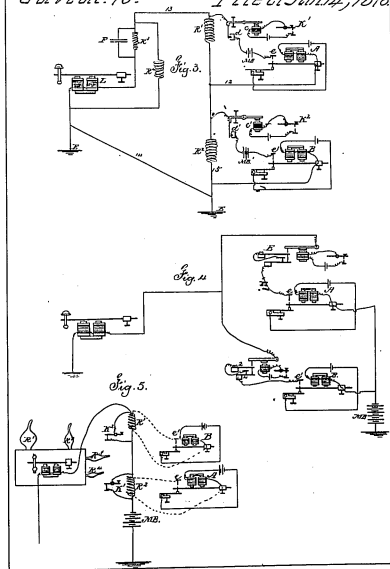
Carpat. 15.

Filed Jan. 14, 1876



T. A. Edison ^{45 Sheet 18}

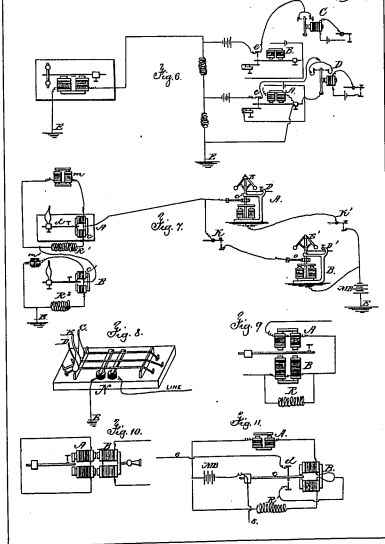
Patent 75. Filed Jan 4, 1876



T. A. Edison, 4, 3 West 57th St. N. Y.

Carpat. 75.

Filed Jan 4, 1876



T. A. Edison ^{4 Sheets Shaded}

Current 75

Filed Jan. 14, 1878

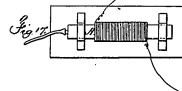
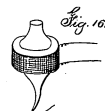
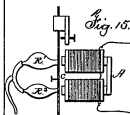
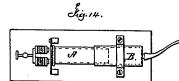
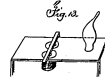
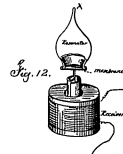
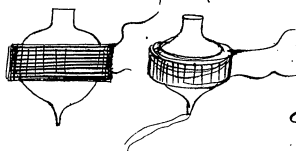


Fig. 16.



Thos. A. Edison
Impr. in
Acoustic Telegraph

Caveat 75

Filed Jan 14 1876

Jan 8, 76

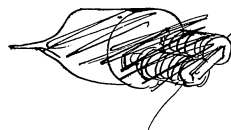
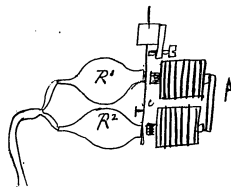


Fig 15 Acoustic Telegraph

Caveat

No. 74.

75



"Sketches for Caveat No 75"
S. L. G.

Telephone Interferences [Volume 2]

The following printed Edison patents, inserted into the volume, have not been filmed:

141,777	Relay Magnets (1873)
158,787	Telegraph Apparatus (1875)
198,083	Telephonic Telegraphs (1877)
198,089	Telephonic or Electro Harmonic Telegraphs (1877)
186,330	Acoustic Electric Telegraphs (1877)
198,087	Telephonic Telegraphs (1877)
182,996	Acoustic Telegraphs (1876)
185,507	Electro Harmonic Multiplex Telegraph (1876)
205,299	Speaking Telegraph (1878)
203,014	Speaking Telegraph (1878)
203,015	Speaking Telegraph (1878)
203,013	Speaking Telegraph (1878)
203,018	Telephone or Speaking Telegraph (1878)
203,016	Speaking Machines (1878)
221,957	Telephone (1879)

Third Edition.]

A. D. 1877, 30TH JULY, NO. 2909.

Controlling by Sound the Transmission of Electric Currents,
and the Reproduction of Corresponding Sounds at a
Distance.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey United States of America, for the Invention of "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS, AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison, at the office of the Commissioners of Patents on the 30th of July, 1877.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "Improvement in Instruments for controlling by sound the transmission of electric currents, and the reproduction of corresponding sounds at a distance."

The vibrations of the atmosphere, which result from human voice or from any musical instrument or otherwise, are made to act in increasing or lessening the electric force upon a line by opening or closing the circuit, or increasing or lessening the intensity of contact between conducting surfaces placed in the circuit at the receiving station; the electric action in one or more electro magnets causes a vibration in a tympan, or other instrument similar to a drum, and produces a sound, but this sound is greatly augmented by mechanical action. I have discovered that the friction of a point or surface that is in contact with a properly prepared and slowly moving surface, is very much increased or lessened by the strength of the electric wave passing at such point of contact, and from this variation in the friction a greater or less vibration is given to the mechanism or means that produce or develop the sound at the receiving station, thereby rendering clear and distinct the sound received that otherwise would not be audible.

To carry out the peculiarities of my invention under the varying conditions of use, I have devised several modifications of the transmitting, receiving, and intensifying devices employed in this sound telegraph; portions of the apparatus are in-

Edison's Impts. in Controlling by Sound the Transmission of Electric Currents, &c.

interchangeably, available in transmitting or receiving; others are adapted to local use; some are only available in transmitting, and others are only for receiving; and some portions of my improvement can be availed of to make a record of the atmospheric sound waves, or of electric waves, or pulsations corresponding thereto or resulting therefrom.

In one form of my apparatus the sound passes into a resonant box having one, two or more tympana at its sides that are vibrated thereby, the tension of these being various, so as to respond to different sound waves, and the electric connections pass through all to one line or circuit, in which is a battery and the distant receiving instrument. Circuit contact points are provided at one or both surfaces of the tympanum or tympana; the tympana are of parchment, foil, mica, sheet metal, or similar material. I find platinum, foil, or mica to respond advantageously when the waves from the mouth are made to pass through a slot resembling the larynx placed within the resonant tube. The contact points or surfaces are sometimes metallic, but plumbago, or similar semi-conducting material, into which the tympanum or diaphragm is brought more or less intimately into contact, or a point or pin thereon serves to lessen or increase the electricity passing at that point.

In the receiving portion of the instrument the tympanum is acted upon directly by an electro-magnet, or through an armature, or the tympanum is provided with an arm extending out over a slowly moving surface or cylinder, and the electric current, passing at the point of contact, increases or lessens the friction, and produces the vibration of the arm and tympanum in proportion to the difference of friction developed between the arm and moving surface by the passage and cessation of the current through the chemically prepared paper, preferably moistened with a salt of mercury and an alkali.

This feature is enabled of very extended development in telegraphy: the clearness and extent of sound produced by the receiving tympanum exceeds any thing heretofore attained in acoustic telegraphs.

The frictional surface may be any material which absorbs liquids, such as chalk, or paper; the transmitting points in all instances should be a poor conductor of electricity, such as crystals of sugar, pieces of lead, or plumbago, which substance may be moulded with non-conductors.

Where plumbago is used between the core and armature of an electro-magnet, and such plumbago is included in a local or relay circuit, the pulsations or rise and fall of electric tension will correspond to that in the coils of the electro-magnet in consequence of the varying compressing action on the plumbago or similar material, which increases and decreases its resistance.

A polarized arm, near a soft iron plate upon the tympanum, will receive a motion from the vibration of the tympanum, and make more or less intimate contact with the plumbago point without arresting the motion of such tympanum.

In the line the effect of the static charges and discharges are neutralized by condensers or by helices in shunts. Where a rapidly revolving wheel is contiguous to the transmitting tympanum, and there is a plate of platinum on that tympanum to which the circuit is connected, the rise and fall of electric tension will result accurately from the movement of the tympanum, producing greater or less contact with the wheel; a spring may intervene between the wheel and tympanum.

A spring or reel, attached to a stud at one end, and the tympanum at the other, is vibrated or modulated by the sound waves acting on the tympanum, and produces greater or less contact with pieces of tin foil surrounding it, which also are in the electric circuit or plumbago; contact points near the side of such spring effect the same

Edison's Impts. in Controlling by Sound the Transmission of Electric Currents, &c.

object. A column formed of disks of tin foil in a glass tube, pressed upon by the vibrations of the tympanum, also are employed under some circumstances to regulate the electric tension in the circuit.

The moving surface, whose friction is increased or decreased upon the passage and cessation of the current as aforesaid, is employed in some instances to vibrate by the electric and mechanical action a frame of strings of different pitch to produce musical sounds, or to give motion to reeds or resonant boxes.

The transmitting tympanum is sometimes made of cloth, with plumbago pressed into its surface, and generally it is preferable to weight the centre of the tympanum, and take the motion a little one side of the centre to prevent a false movement or rebound. These sound transmitting and receiving instruments are applied in single or multiple telegraphs; the connections through the Wheatstone bridge, or the induction coils, being used in the well known ways, and the circuits being either single or relays.

Where aluminium is introduced in the electric circuit in connection with a material containing an electrolyte, the vibration of the tympanum, and an extension from it to the material containing the electrolyte, causes a depolarization at the point of contact at every vibration, thus increasing and decreasing the strength of the current by depolarization.

Where a slot is made in the diaphragm, and the airways impinge against the same, the vibration of the living sounds is augmented.

The resonant chamber for convenience is made portable, so as to be presented to the mouth.

In addition to the tympanum for transmitting the vocal sounds, I employ another opening in the speaking tube or chamber, which opening may be increased or lessened; I stretch edgewise over this a thin reed of foil, which is set in vibration by all hissing consonants, and make contact with a plumbago point, or with a platinum point, which is connected to the line through an adjustable resistance coil, or a self-acting reel giving a rise may be thrown in and out of circuit by the movement of the foil reel.

For transmitting and receiving letter by letter, I employ a shaft with 20 wheels, and contact springs resting upon them; the wheels are provided with teeth of such number and character that they will cause the springs to be charged against a plumbago point the necessary number of times, and with proper pressure to transmit the letter, which is rendered audible at the distant station by the magnet or frictional surface. Each wheel is controlled by a key of a key board.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 20th January, 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN INSTRUMENTS FOR CONTROLLING BY SOUND THE TRANSMISSION OF ELECTRIC CURRENTS, AND THE REPRODUCTION OF CORRESPONDING SOUNDS AT A DISTANCE."

This invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and the same sound is produced at the receiving station, so that oral communications can be sent by electricity and clearly distinguished at the receiving station. Musical tones may also be sent, but my present invention is especially available in transmitting and receiving oral communications. In transmitting musical tones, the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent, but in speaking there is little change in the musical tone, but considerable in the modulations and inflections of the voice. In my present invention I make use of the vibrations given to a diaphragm or tympan, by speaking into a resonant tube, to produce a rise and fall of electrical tension upon the line with such accuracy that the electrical pulsations or waves will represent the atmospheric sound waves produced by articulation, and the electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate.

The instruments in a complete form are represented in Figs. 1 and 2, Fig. 1 being a section of the transmitting instrument, and Fig. 2 of the receiving instrument.

The resonant tube or box *a* is of a size and shape adapted to being spoken into, the same having an opening at one end or side and a diaphragm or diaphragms *b*, against which the sound waves from the human voice act, and these and the motion that the diaphragm receives is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery *B* connected to the line *f* will transmit a greater or less current to the distant electro-magnet *m*, Fig. 2, and increase or lessen the magnitude of the eaves, and in so doing set upon a resonant plate, and develop sound corresponding to the articulation at the transmitting station.

The general features thus described pervade my entire invention, but in developing the same many useful and important modifications and variations have been made, which I will proceed to set forth.

For convenience the speaking instrument, Fig. 1, is provided with a handle *a'*, and flexible conductors to the battery and line respectively, so that it may be handled and brought to the mouth, and in like manner is preferable to place the hearing instrument, Fig. 2, in a movable handle *e'*, so that it can be played with the plate against the ear; this brings the sound close to the organs of hearing, and the resonant plate touching the ear increases the distinctness of the sound, and prevents any false or prolonged vibrations of the plate.

In some of the modifications I have shown the speaking instrument as a fixture and also the hearing instrument as a fixed resonant tube, these being variable to suit the persons or the places.

The first special feature that requires separate consideration is the peculiarity of the resonant tube for the voice. I have experienced great difficulty in reproducing the sound of the living resonant, such as *a*, *e*, *i*; this appears to arise from the fact that this sound is deflected downwardly in leaving the mouth, and does not act distinctly upon the diaphragm. By providing an edge in the resonant tube below the mouth, upon which such resonant sounds are received, the vibrations are given either to the resonant tube, or deflected to the diaphragm. I find it preferable to employ a hole *c* at the lower part of the *a* mouth piece, against the edges of which the downward sound waves are directed. The same effect will be produced by a vibrating edge placed in the lower part of the mouth piece, or the opening into the resonant box may be contracted to about half an inch in diameter to effect the same purpose. The next feature requiring consideration is the character of the diaphragm in the speaking instrument.

Many materials have been employed by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of these produce a prolonged, or secondary vibration from their own resonant character, hence the articulation is defective, and the sound vibrations bleed. After extensive experiments I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when severed at its edges responds with the greatest accuracy to the sound vibrations, and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diaphragm or tympan.

I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission is produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small lamines or tufts, or disks of semi-conducting elastic fiber, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator; it is more or less compressed, according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fiber expands.

This fiber is placed in a small coil *c*, between the delicate diaphragm spring *r*, Fig. 3, and the variable pressure *e*, adjustable by screw or otherwise in the electric circuit at this point, or it may be within a cavity in said pressure *e*, as in Fig. 1, there being a delicate eave-center piece *v* to the diaphragm *b*, with a piece of platinum foil in contact with the fiber; in all instances the telegraphic circuit at the diaphragm is made by a thin strip of platinum or similar material extending to the center from the fiber or battery connection.

The fiber is rendered semi-conductive by being ruled with plumage, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, the conducting power varying with the density of the tuft or bunch of fiber. The delicate spring *r*, Fig. 3, upon the mica diaphragm *b* is easily secured by solder passing into fine holes bored in the mica.

In Fig. 3 the tension regulator is made by water or other semi-conducting elec-

Edison's Impts. in Controlling by Sound the Transmission of Electric Currents, &c.

residue fluid in a cup *f*. The wires to the battery are led to the electrodes or conducting points 2, 3, in such cup that are opposite to points 4, 5, upon the diaphragm *b*.

The cup is adjustable to vary the distance between the electrodes and the rise and fall of tension results from the varying distance between the electrodes as moved by the vibrations of the diaphragm. If there are several electrodes opposite to each other and insulated, except at their ends, and the circuit led from one to the other, so that the current passes through all the electrodes in succession, the rise and fall of electric tension will be promoted, because the smallest vibration of one set of electrodes is multiplied by the number of places at which the metallic circuit is interrupted or varied. In the receiving or hearing instrument the resonant plate *e* should be of tinued iron, resting upon the edges of the case, and the magnet *m*, adjustable, nearer to or further from the same, and connected loosely by dotted lines. This plate will respond to the electric pulsations by the attraction of the magnetized cores, and the sound resulting will be amplified when the plate is placed near or against the ear. If the plate is pressed away from the magnet by a delicate spring, or allowed to fall away from the magnet, the instrument may be used as a call by using a key or switch at the sending station to open and close the circuit, and thus move the plate to give a loud sound. In some cases I make use of a variable resistance resulting from a greater or less intimacy of surface contact such as would result from a disk covered with plumbago placed adjacent to a diaphragm, also covered with plumbago or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the telegraphic circuit. I also sometimes employ a shunt circuit in the line, or a branch circuit to the earth, in which is placed an electro magnet to neutralize any static charge or discharge in the line. I sometimes perforate the diaphragm *10*, Fig. 18, and place a strip of elastic material, *40*, across said diaphragm over the hole, and upon this piece afford, so that the same responds to very weak vibrations, and in some instances two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters or tensions, so as to respond to varying sounds or acoustic condition, the various tension regulators being all in the electric circuit; this will produce greater rise and fall of tension for longer lines in consequence of the diaphragms spring simultaneously on the tension regulators. In some instances it is preferable to make the mouth piece of the speaking instrument sufficiently large or flaring to receive all the sound vibrations, whether coming from the mouth, nose or throat.

Several contact points of platina, placed contiguous to the diaphragm, may be used, the same acting to increase or lessen the surface contact, according to the amplitude of vibration of the diaphragm, and a drop of liquid such as oil or glycerine between the contact point and diaphragm, will serve to maintain a closed circuit, but the movement of the diaphragm produces rise and fall of tension. The tension regulator, formed of fiber and conducting or semi-conducting material, may be either dry or moistened with a liquid.

In some instances I make use of the best quality of lamp black retained within a case to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm.

I am enabled to record the sounds produced by the human voice or otherwise by

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causing the movements of the diaphragm to be registered on paper or soft sheet metal, and then the paper may be used in an instrument to reproduce the sound upon a delicate diaphragm by giving to the same a vibration similar to that originally given by the voice. *h*, Fig. 4, is the indenting transmitter, the diaphragm having a knife-edge point. *i* is the paper which has previously been passed through a machine to raise a V-shaped rib *6*. The movement of the diaphragm of *h*, when the drum is in motion, causes the knife-edge point *f* to indent the raised ribs to varying depths, according to the amplitude of vibration of the diaphragm, thus these indentations represent accurately all the tones and varying inflections of the human voice. The paper after being indented is passed through a second apparatus *n*, Fig. 5, almost similar to *h*. A spring *9* has a knife-edge which rests upon the raised indented ribs *5*, the spring being connected to a delicate diaphragm *10* by a string of straw. The indented ribs reproduce in the spring *9* the movement of the indenting point, and either by direct action, or through the vibration of a string, conveys the same motion to the diaphragm of *n*, and reproduces perfect sounds.

If these sounds are to be transmitted over a telegraph line the diaphragm *10*, see Fig. 8, is provided with a rock disk *11*, and allows tension regulator *1*, before described, to produce the rise and fall of electric tension on the line. The sound may be recorded in ink as represented in Fig. 7. The diaphragm of *h* operates a very flexible self-feeling pen, and causes the continuous line to be wide or narrow, according to the amplitude of vibration of the diaphragm. The ink need should dry quickly, and the strip may be passed at any time thereafter through the instrument shown in Fig. 8, beneath the arm *12*, having a point or points resting on the paper; this arm is connected with a resonant diaphragm, and the ink marks produce more or less friction, according to the breadth and amount of ink deposited, and this will act on the diaphragm of *n* vibrating, and reproduce the vibrations of the diaphragm of *h*. An obvious modification would be to coat the paper with a substance which would cause considerable friction, or even rough metal paper might be used, and a spring provided, with a lamellar point, rather flat, would cause the surface of the paper to be made smooth more or less, according to the vibration of the diaphragm, and the differences in the surface of the paper would produce a response in the receiving diaphragm.

I sometimes arrange the battery in connection with the transmitting instrument, as shown in Fig. 10. *b* is the resonant chamber at the end of which is the diaphragm *10*, and at each side of this diaphragm there are springs *e'*, *e'*, having points made of compressed plumbago suited perfectly with gum rubber, but any substance not liable to rapid discoloration, or the double or fibrous tension regulator also might be used. These points face each other on opposite sides of the diaphragm, and make contact with platina foil disks secured to the diaphragm. The spring *e'* passes through a hole or small slot in the side of the chamber *b*. The battery *e'* has one pole to the line or spring *e'*, and *e'*, *e'* are the other both to the line or spring *e'*. When the springs *e'* and *e'* are adjusted to make contact with the diaphragm equally, no current passes to the line; but when the diaphragm is vibrated, its movement to one side, say *e'*, causes line; but when the diaphragm is vibrated, its movement to one side, say *e'*, causes line; but when the diaphragm is vibrated, its movement to one side, say *e'*, causes a greater pressure upon the plumbago on that spring, and a lessening of the pressure on the plumbago on *e'*; hence the balance of the batteries *e'* and *e'* will be destroyed, *e'*, having the advantage, will send a negative current to line; upon the return of the diaphragm the battery current will again neutralize each other. The

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vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery $\mathcal{B}$ will send a positive current to the line. As the tension regulator of filter or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. In Fig. 11 is shown the contact spring, which may be used adjacent to the diaphragm at one or both sides thereof. $\mathcal{C}$ is a V-shaped spring secured to the screw $\mathcal{A}$, which is adjusted back and forth by the thumb nut $\mathcal{D}$; $\mathcal{E}$ is the pillar holding such screw; $\mathcal{F}$ is a piece of soft rubber, or equivalent substance, placed between the prongs of the spring $\mathcal{C}$; $\mathcal{G}$ is a wire or lead which serves to bind the prongs tightly against the rubber $\mathcal{F}$, so as to prevent the prongs acting as a tuning fork, and transmitting harmonic vibrations not desirable; $\mathcal{H}$ is the plumbago contact point. The object of the V-spring and rubber is to prevent a non-field point for contact, so as to prevent a rebound, and allow of a slight yield when the plumbago is pressed by the

In Fig. 3 the diaphragm of the receiving instrument is vibrated by a strip of paper elastically prepared that is in motion, the pulsations of electricity passing over the line and producing more or less friction between the paper and an arm upon the diaphragm. The resonant box or chamber a is provided with a diaphragm as above said, and to said diaphragm an arm b is connected; at its outer end is an adjusting screw c , that passes upon a platinum-faced spring d that is secured to this arm, and said spring rests upon the strip of paper that passes over the drum e . The paper is moved slowly by rotating the drum e , and the waves of electricity coming over the line pass through the arm b to the platinum-faced spring d , thence through the paper to the earth. If a negative current passes in the opposite direction, nearly all friction between the platinum plate and the paper ceases, and the diaphragm of the resonant box a regains its normal position. When the positive current passes through the same channel, the normal friction of the paper is augmented, and the elastic surface acting upon the platinum spring arm serves to give a forward movement to the diaphragm of the resonant box. Thus the mechanical force applied to move the electrical paper or surface acts with the electric current to produce the vibration of the diaphragm of the resonant chamber, and these vibrations will correspond to those of the diaphragm h , made by speaking in the tube a . The principle of this method of obtaining motion by electrochemical decomposition is, that when a moving surface is in contact with a slightly yielding substance, the tendency is to move the latter and with the former. If the circumstances of contact are varied, the adhesion of the surfaces will be sufficient to cause the moving surface to move the yielding substance, or else to cause the yielding surface to slip more freely, and by its spring go in the opposite direction to the moving surface. The passage of electricity at the surfaces in contact will change the frictional adhesion, making it more or less, according to the substances employed.

By following the mechanical forces, so that when the surfaces in contact are not electrified the moving surface carries the yielding surface; and when, electrified, the yielding surface slips back over the moving surface, a mechanical movement is obtained that is dependent on the electrical condition of the surfaces in contact.

When it is required to obtain very perfect articulation, and when loudness is not essential, I adopt a modification, shown in Fig. 12, of the device for compressing and expanding the tuft of conducting filter, which modification consists in placing between the diaphragm 10 and the filter f a vibrating tongue 21 of steel, perma-

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mentally magnetized, and arranging it to act in the same manner upon the tension regulator f as if it was the diaphragm. I replace the cork upon the diaphragm by a thin armature of line 22 which is in close proximity to the magnetized tongue, by which tongue is secured at one end like an acoustic reed. In this position the diaphragm is free to move, and at its approach to and recession from the magnetized tongue causes said tongue to follow its movements by magnetic attraction, and thus the tongue is made to perform what the diaphragm previously performed in, and varying the tension of the electricity on the line.

A modification of the magnetic receiving instrument consists in an iron plate fitted into the aperture of a resonant tube, and secured by a central support, leaving its outer circumference free to vibrate when the metal is attracted by the poles of the electro-magnet, which are of course on each side of its center; but it is preferable to place the support slightly out of center, as some portions of the plate will then be in tone for every sound. A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice; the circuit with this plate is completed through one or more tension regulators placed around its edges. I have discovered that vulcanite or hard rubber produces cold and heat waves on its surface by the slightest movement, and in some cases I employ the same for the diaphragm of the resonant case h , Fig. 13, and place a thermo-electric pile k in very close proximity to the rubber, so that the vibration of the diaphragm h producing changes of temperature will cause currents of electricity to be set up within the thermo-battery, and these passing over the line l and acting upon a very delicate electro-magnet and diaphragm will reproduce the sounds acting upon the rubber diaphragm.

In practice I combine with the speaking or telephonic apparatus signal bells, so arranged that when the telephone is not in use the line is thrown upon the bell by a switch, which also acts as a call on the bell. One feature about the bells is that the magnet which serves to actuate the bells is made of very high resistance, using preferably German silver wire in the helix, and thus serve to prevent a rapid consumption of battery power.

A large number of telephonic wires may be worked from one battery if these bells are used. The method I adopt for coating non-conducting substances with metallic substance is the reduction to the metallic state of metals from their salts by exposing them to the fumes which arise from the moist phosphide of a metal, such as phosphide of calcium, or by placing the salt, for instance, in a sealed tube provided with metallic electrodes, and volatilizing the electrodes by the passage of electric spark; such volatilized metals settle upon and coat the salt.

When great loudness is desirable, as in factories, the trumpet of the receiving instrument may be made to contain an air valve of a reed or in which air is stored under a regulated pressure. The air allowed to escape will act with great power upon a loud diaphragm. This diaphragm, to obtain clear sounds, requires a damper to check prolonged vibrations. It may be damped by holding the finger against it, or by a tightly stretched cord rubbing against it, or by a screw provided with a rubber tip held against it. For repeating from one circuit into another I use with the receiving diaphragm the elastic tension regulator Fig. 14 in addition to the electro-magnet, and connect the relay or second circuit through the same, so that waves received from the distant station cause the magnet to vibrate the diaphragm, and this acting upon the tension regulator transmits the waves into the second circuit, and they are received at the other end by an electro-magnet and diaphragm. In some instances I make a record of the sound by the movements of the dis-

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phragm, using for that purpose a strip of paper moved along regularly between two rollers, 25, 26, as in Figs. 14 and 15; and there is a smooth thread or fine wire of soft metal 29 between the paper and the upper roller 25, and moving along with it. The diaphragm 10 of the resonant box is connected by a delicate rod 28 with this thread or wire as near to the light of the roller as possible, their being a fork or eye through which the thread passes, hence deflections or bends are made in the thread or wire just before it is included into the paper by the pressure of the rollers; this may be used to reproduce the sound by vibrating a resonant diaphragm by the vibrations of the groove made by the thread or wire.

By placing the fibrous tension regulator within a small hand of vulca rubber the same is rendered more elastic, and the flow is allowed to expand by the heat of the current without altering the electric tension. In cases where a strip of metal rubber or a coil of silk or other material coated with plumbago or metallic fall is introduced between the diaphragm and a rigid support, the expansion and contraction due to the passage of the electric currents will produce a movement upon the diaphragm corresponding to the diaphragm producing the electric pulsations. In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympan 10, Fig. 17, a small cylinder *C* of hard rubber or non-conducting material within which is the fibrous tension regulator *T* resting upon a piece of platinum foil connected to one pole of the battery, and within this cylinder *C* is a disk *P* of iron or other metal, loose, but pressed towards the tension regulator by a spring *F* and screw cap *F*, and the other electric conductor is connected with said spring. The inertia of the metal disk causes more or less compression of the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk *P* to a yielding spring *P'* that extends across from one edge of the diaphragm to the other, as seen in Fig. 16. This construction of tension regulating device is especially available with large diaphragms. In some cases I use a soft rubbery diaphragm immediately in contact with the transmitting or receiving diaphragm, so as to check or dampen any prolonged or false vibration, and render the sound more clear and free from prolonged tones. In preparing the tension regulator I find in some cases that it is preferable to use lamplack mixed with pure plumbago, amorphous phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate.

In Fig. 19 I have represented the circuit as passing through the diaphragm 10, tension regulator *L* and a Duhno dry pile battery *B*, *P*, *R*, to the earth. This battery is composed of about 200 pairs of paper disks coated with silver and black oxide of manganese. Fig. 20 illustrates the device before mentioned for intensifying the sound; 10 is the diaphragm vibrated by the sound; 42 is a valve moved by such diaphragm; 43 is a reservoir containing air under a given pressure; 44 is the diaphragm against which the air, allowed to escape by the valve, acts; and *L* is the tension regulator to transmit the electric pulsations, or a hearing resonant case may be applied at the same place.

Many curious and useful features have been developed by my extended researches in the transmission and reproduction of sound. Among these may be mentioned the fact that a copper diaphragm, or diaphragm of mica or other flexible material containing copper, will act with the core of a polarized electro-magnet in transmitting or receiving. If a diaphragm with a metallic button upon it is so close to the

core of a permanent magnet, see Fig. 21, that the vibrations of the diaphragm by sound cause such button to strike the core a corresponding electric pulsation will be set up in a helix around the magnet, and the same will act in an electro-magnet at the distant instrument by molecular disturbance.

If the diaphragm 10 has a thin tube attached to the centres, as in Fig. 22, and this project into the helix around one pole of magnet 48, the current set up in that helix by the vibration of the diaphragm and tube will be much greater than that resulting from a flat armature on the diaphragm or the diaphragm itself. The core of the permanent magnet 48, Fig. 23, is removed with the plate so that the latter is polarized by induction, the current set up in the helix around one pole of the said magnet is intensified. In this case I groove the end of the helix, and insert a small piece of soft rubber or tubing that serves to dampen the vibrations of the diaphragm, and prevent false or harmonic vibrations in speaking. Fig. 24 represents the diaphragm 10, tension regulator *L* with its adjusting screw and local circuit containing the battery *B*, passing through a primary induction coil 49, and there is a key 50 in the same circuit. A secondary induction coil 51 is in the line circuit, and is influenced electrically by the change of tension in the local circuit by the vibrations of the diaphragm 10. The secondary coil is sometimes required with many layers of fine wire to set up current of high tension to overcome the inductive effect from the line wires, being adjacent to each other. I place the receiving instrument at the distant station between the induction coil and the earth as at *R*, and use an electro-magnet *E*, *M*, with polarized armature to strike a bell; this will respond when the key 50 in the local circuit at the distant station is opened and closed. In Fig. 25 a similar induction coil 49 and local circuit is represented, but the tension regulator is made of platinum foil upon the surface of two soft rubber tubes, one on the diaphragm, the other on the adjusting screw. A shunt and rheostat at *R'* serves to produce the magnetism in the induction coil, and thus ensure a gradual rise and fall of electric tension in the line instead of a cessation of the same when the platinum foil separates, and at the receiving diaphragm *R*, the rise and fall of electric tension in the line and its helix acts upon the permanent magnet to produce the vibrations of the diaphragm *r*, and by connecting a shunt around the helix, and placing therein the secondary battery *S*, *R*, composed of metallic plates in acidulated water, the action is rendered more uniform and the sound distinct. When the diaphragm is arranged as in Fig. 26 to act upon a spring 26, through an intervening piece of soft rubber, said spring 26 produces rise and fall of electric tension by coupling a range of resistance 27 with spring tongue adjacent to 26. The greater amplitude of vibration of the diaphragm the more direct will be the electric circuit connections and the less resistance, because the circuit will pass along the spring instead of going through all the resistance coils. When there is an electrophorus or resonant disk 58, immediately facing each diaphragm 10, as in Fig. 27 and the line connections are made to the diaphragm and the earth, these connections are made to these electrophorus disks 58, the diaphragm will respond to each other in either speaking or hearing. Where several line wires run near each other, the wire used for the acoustic or speaking telegraph is influenced by induction, and false sounds will be produced. I counteract this tendency by placing one or more electro-magnets 50, Fig. 28, in the circuit of the speaking telegraph, and one or more electro-magnets 60 in the circuit of the adjacent wires, and bringing the opposite cores of 60 at such a distance from the cores of 50 that and bringing the opposite cores of 60 at such a distance from the cores of 50 that a certain magnetic action will be set up in 50 by induction in the opposite

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direction to the induction currents from the adjacent line or lines. By adjusting the distance between these magnets when the speaking telegraph is not in use, until there is not any sound at the diaphragm from the induction currents, then these currents will be neutralized, whether strong or weak, and will not produce any false sound when the speaking telegraph is in use. I also employ double coils of wire for the same purpose, one coil being in the acoustic wire, and the other in the wire to be compensated.

A convenient form for the sound recorder or phonograph is to employ a cylinder *at*, see Fig. 29, having a helical groove in its surface covered with tin foil, and the cylinder is revolved regularly by clock work, and moved endwise by a screw on its shaft, so that the indenting point *P* from the diaphragm *to* of *b* will be always in line with such groove, hence the vibrations of the diaphragm will be recorded by indenting the foil into the groove, and hence the same sound will be reproduced by the point *P* of the hearing instrument *a*, giving to the diaphragm of *a* the motions that result from the indentations of the foil moving in contact with such point. The foil may be on a flat grooved plate and be indented and act as before named.

I claim as my invention:—

First. In an instrument for transmitting electric impulses by sound, a diaphragm or tympan of wax, substantially as set forth.

Second. In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of an electric tension regulator for varying the resistance in a closed circuit, substantially as set forth.

Third. The combination in an electric instrument actuated by sound, of a diaphragm or tympan, a conductor, and an electric tension regulator composed of yielding material and electric conducting material.

Fourth. The combination with the diaphragm and electric conductor, of the cork disk and tension regulator, substantially as set forth.

Fifth. In a telegraph operated by sound, the transmission and reproduction of the human voice by increasing and decreasing the resistance of the circuit, substantially as set forth.

Sixth. The combination with a diaphragm or tympan, of electrolytic fluid and electrodes, the latter being vibrated by the diaphragm and varying the resistance in the electric circuit, substantially as set forth.

Seventh. In an instrument for transmitting sounds by electricity, a resonant case having an opening or edge, against which the consonant sounds act, substantially as set forth.

Eighth. In combination with the diaphragm or tympan and the electric tension regulator, the adjusting screw or variable presser to regulate the resistance of the tension regulator in the electric circuit, substantially as set forth.

Ninth. The combination with a diaphragm in a speaking telegraph instrument of a moving surface, and a recording mechanism actuated by the diaphragm or tympan, substantially as set forth.

Tenth. The combination with a receiving diaphragm or tympan in a telegraph operated by sound, of a moving surface, a point, and a connection from the same to the diaphragm, substantially as set forth.

Eleventh. The combination in an instrument for receiving sounds electrically, of an electro-magnet and armature plate, substantially as set forth.

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Twelfth. The combination in the telegraphic circuit of two or more tympana, a resonant box, and one or more circuit closers to each tympan, substantially as set forth.

Thirteenth. The combination with the diaphragm of a resonant case, of circuit connections at both sides of the diaphragm and a battery, substantially as shown in Fig. 10.

Fourteenth. In a telegraph instrument operated by sound, a resonant box or case, a diaphragm and flexible circuit connections, substantially as set forth, whereby the instrument is made portable, and can be placed to the mouth in speaking.

Fifteenth. In a telegraphic instrument operated by sound, an electro-magnet and resonant plate or diaphragm provided with a handle and flexible conductors, substantially as set forth.

Sixteenth. The receiving instrument consisting of an electro-magnet, a case, and a loose metallic plate arranged and operated substantially as set forth, to act as a call or to receive the message.

Seventeenth. In a telegraphic apparatus operated by sound, one or more contact points of yielding material that produce a rise and fall of tension proportioned to the pressure exerted by the diaphragm, substantially as set forth.

Eighteenth. In a telegraphic apparatus operated by sound, a receiving instrument provided with a resonant surface, in combination with a frictional surface moved by power and acting in connection with the electric current to vibrate such resonant receiver, and produce tones corresponding to those at the transmitting apparatus, substantially as set forth.

Nineteenth. The combination with a thermo-electric pile of a vulcanite or hard rubber diaphragm, substantially as set forth.

Twentieth. The method herein specified of recording the undulations of the diaphragm or yielding material, and the reproduction of sound by such material acting upon a diaphragm to communicate to the same vibrations similar to the original ones, substantially as set forth.

Twenty-first. The combination with the diaphragm and tension regulator of a magnetized tongue and an iron plate upon the diaphragm, as set forth and shown in Fig. 12.

Twenty-second. In combination with the diaphragm operated by sound, an electro-magnet, a valve, and a chamber of compressed air or gases to reproduce the sounds in louder tones.

Twenty-third. The method herein specified of preparing fiber for electric tension regulators by conducting or semi-conducting material associated intimately with such fiber, substantially as set forth.

Twenty-fourth. In an instrument for receiving sound telegraphically, a plate loose at its edges, and supported upon a post or standard, substantially as set forth.

Twenty-fifth. The combination with the sending and receiving diaphragm of the dry pile illustrated in Fig. 19.

Twenty-sixth. The combination is a telephonic instrument, of an iron diaphragm and a magnet, one end of which is attached to the magnet, substantially as specified.

Twenty-seventh. The combination with the electric circuit and a diaphragm of an induction coil and magnet, substantially as set forth.

Twenty-eighth. The combination with the induction coil, diaphragm, and loss

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circuit of a key in said circuit, and a call or sounder at the distant station, substantially as set forth.

Twenty-ninth. The combination with a diaphragm of rheostats or resistances in the line or local circuit, and means for short circuiting such resistances in proportion to the movement of the diaphragm, substantially as set forth.

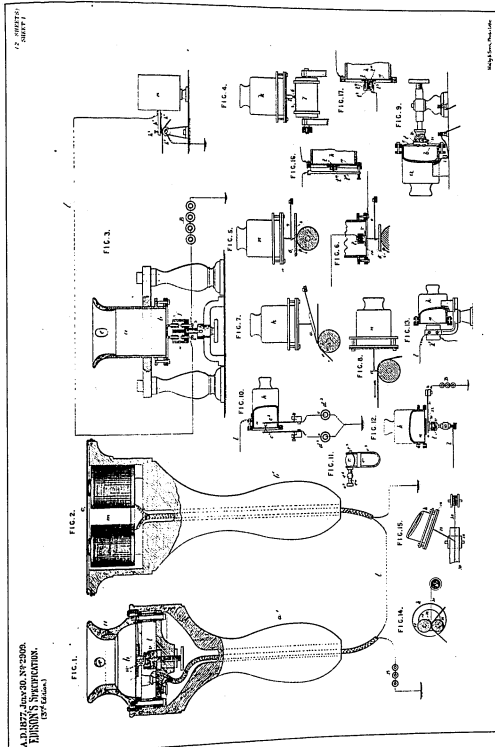
Thirtieth. In combination with an electric circuit containing instruments for reproducing sound, one or more electro-magnets and one or more compensating magnets for neutralizing the inductive effect of adjacent telegraph wires, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereto set my hand and seal, this twenty-fourth day of December, A. D. 1877.

THOMAS ALVA EDISON. [L. S.]

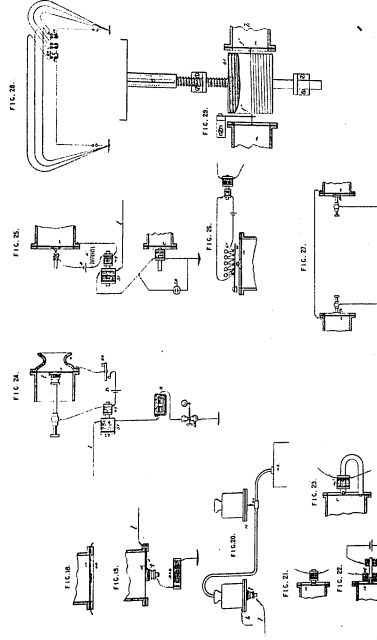
Witnesses—

CHAR. H. SMITH, 76 Chambers Street, New York.
WILLIAM G. MOTT, " " "



AD 1857, AUG 30, NO 2409.
 EMBROIDERY MACHINE.
 (278 claims.)

Fig. 1.



Learned by the use of the machine and the machine is not a machine.

Fig. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6. FIG. 7. FIG. 8. FIG. 9. FIG. 10. FIG. 11. FIG. 12. FIG. 13. FIG. 14. FIG. 15. FIG. 16. FIG. 17. FIG. 18. FIG. 19. FIG. 20. FIG. 21. FIG. 22. FIG. 23. FIG. 24. FIG. 25. FIG. 26. FIG. 27. FIG. 28. FIG. 29. FIG. 30. FIG. 31. FIG. 32. FIG. 33. FIG. 34. FIG. 35. FIG. 36. FIG. 37. FIG. 38. FIG. 39. FIG. 40. FIG. 41. FIG. 42. FIG. 43. FIG. 44. FIG. 45. FIG. 46. FIG. 47. FIG. 48. FIG. 49. FIG. 50. FIG. 51. FIG. 52. FIG. 53. FIG. 54. FIG. 55. FIG. 56. FIG. 57. FIG. 58. FIG. 59. FIG. 60. FIG. 61. FIG. 62. FIG. 63. FIG. 64. FIG. 65. FIG. 66. FIG. 67. FIG. 68. FIG. 69. FIG. 70. FIG. 71. FIG. 72. FIG. 73. FIG. 74. FIG. 75. FIG. 76. FIG. 77. FIG. 78. FIG. 79. FIG. 80. FIG. 81. FIG. 82. FIG. 83. FIG. 84. FIG. 85. FIG. 86. FIG. 87. FIG. 88. FIG. 89. FIG. 90. FIG. 91. FIG. 92. FIG. 93. FIG. 94. FIG. 95. FIG. 96. FIG. 97. FIG. 98. FIG. 99. FIG. 100.

[Second Edition.]

A. D. 1878, 15TH JUNE, NO. 2306.

Telephones and Apparatus Employed in Electric Circuits.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey United States of America, for the invention of "IMPROVEMENTS IN TELEPHONES AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

PROVISIONAL SPECIFICATION left by said Thomas Alva Edison at the Office of the Commissioners of Patents on the 15th June, 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America, "IMPROVEMENTS IN TELEPHONES AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

In this apparatus I make use of a plate or body against which the sound waves in the atmosphere act, and connected therewith is a button or button of carbon or other semi-conducting material placed in the electric circuit. The pressure due to the impact of the sound waves acts on the carbon, and produces the rise and fall of electric tension in the circuit.

The circuits are arranged to bring into action one or more primary and secondary currents, and an induction coil or coils, and switches and a call, so that signals can be sent and messages transmitted in opposite directions over one line. The receiving instrument is provided with an electro-magnet and an armature formed of an iron plate diaphragm, and a hammer is attracted or repelled *as it* to strike upon the diaphragm to form a call, and a stand is used to keep the telephone instruments in proper position for the call to act.

Two or more vibrating instruments connected in the same circuit, and operated by electro-magnets are thrown out of the circuit by a shunt, and act to give signals in two distant instruments provided with diaphragms. I employ a condenser in the local or main line circuit to neutralize the static charge or discharge, which condenser is preferably made of two strips of foil wound into a spiral form, and to which strips the respective circuit with non-conducting material intervening, and the carbon employed in the circuit is preferably the finest quality of selected lamp-black, consolidated by heavy pressure, but plumbago and various forms of

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carbon or ball of copper, black oxide of manganese, finely divided metals peroxide of lead, or similar semi-conducting materials reduced to a powder and moulded in buttons or discs may be employed.

The induction coils serve to throw into the line a powerful induced current, and in some instances, to employ a battery connected with the line, and balanced so that the sound waves acting on the carbon or other resistance, cause either the positive or negative of the battery to preponderate on the line. The condenser introduced in the same circuit gives both static and induction currents. Fine wires may take the place of the strips of galvanized iron.

Where the air waves strike upon a vibrating plate or disc, the change of pressure upon the carbon may be obtained from a thin strata of air intervening between the diaphragm and the platinum plate of the carbon.

A magneto-electric machine is sometimes used as the source of electric energy in place of a battery, and the telephone instrument placed in the Wheatstone bridge, and placed resistances to balance the electric forces, so that variation of the resistance in the telephone sends the current on the line.

Telephones in local circuits or shunts at way stations, with induction coils in the main line, are used for operating local telephones on the main line.

The sound vibrations act by leverage upon the carbon or other resistance, to increase or lessen the motion as circumstances require.

A secondary battery in some cases is employed in place of a condenser, and a thermal battery can be employed as the source of electric energy.

Where the electric current is made to pass through water or an electrolytic solution, the diaphragm acts upon a valve or cut-off, to vary the volume of liquid where the current passes, and effect a rise and fall of electric tension.

A Dulac dry pile is combined with a diaphragm at each terminal for transmitting and receiving sound.

An electrophorus similarly combined is sometimes employed for the same purpose.

Calls are combined with the telephone so as to attract attention to the instrument.

These calls are operated by pendulums, forks, or reeds, which set up magneto-electric currents when vibrated, and from these the bell or other receiver effects its movement from the distant station.

The receiving portions of the telephone are of a character adapted to respond to the electric pulsations from the transmitting telephones aforesaid.

Sometimes there are two or more receiving diaphragms to an air chamber to augment the sound.

It is important to use a damper upon a diaphragm to prevent false vibrations.

Mercury globules receiving motion from the electric action are sometimes employed to actuate the receiving diaphragm, and the magnet of the receiving diaphragm is polarized with a local battery and double coils.

A diaphragm connected directly upon the induction coil will respond to the electric waves and give audible sounds.

In place of flexible wires for the telephone connections, wires with universal joints are preferable.

Long funnels are used with the telephonic receiver to increase the volume of sound.

The expansion or contraction of gases and other materials by change of temperature or hygienic condition are employed to vary pressure upon the carbon button

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or disc between its two platinum armatures, and a galvanometer in the circuit by its movement indicates with the greatest and most absolutely certain accuracy the extent of the disturbing cause that is exerted on the carbon.

The galvanometer may be wound differentially or placed in a Wheatstone bridge. Induction coils are made of forms specially adapted to the telephone apparatus, and the condensers are sometimes connected in a continuous metallic circuit.

10

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 18th December 1878.

15 THOMAS ALVA EDISON, of Mend Park, in the State of New Jersey, United States of America, "INVENTOR OF THE TELEPHONE AND APPARATUS EMPLOYED IN ELECTRIC CIRCUITS."

In this apparatus I make use of a plate or body against which the sound waves in the atmosphere act, and connected therewith is a button or button of carbon or other semi-conducting material placed in the electric circuit. The pressure due to the impact of the sound waves acts on the carbon, and produces the rise and fall of electric tension in the circuit.

Fig. 1 is a vertical section of the transmitting instrument, and Fig. 2 is a plan of a portion of the same.

The body of the instrument is made of the two shells *a* and *b*, between which the diaphragm *c* is clamped at its edge, and said diaphragm receives the impact of the sound waves which enter through the opening or mouth piece *f*; *e* is a disk of non-lathing material secured to the screw *g*, and in a cavity in this disk is the carbon button *h* between the platinum disks 1 and 2; the disk 2 is secured to the screw *j*, and the disk 1 is connected to the metallic ring 3 by a strip of platinum 4, in order that said disk 1 may be free to move.

The disk 1 is connected to the wire 5, and the disk 2 to the wire 6. Upon the diaphragm *c* there is a short tube *i* that rests upon the disk 1. As said diaphragm receives the impact of the sound waves, the carbon button is subjected to different pressures, and varies the resistance to the passage of the electric current through the same, consequently, the current passing in the circuit is varied in its electric tension; this current acts in the distant receiver as hereafter explained, to give movement to a diaphragm, and produce sounds corresponding to those which are received upon the diaphragm *c*. The screw *f* allows of the carbon button and disks 1 and 2 being raised or lowered to adjust the initial pressure of the diaphragm on the carbon button.

The carbon employed for the button *h* is preferably the finest kind of selected rector carbon, or various compounds, but plumbago, carburet of iron, gas lamp-black consolidated by heavy pressure, and plumbago, carburet of iron, gas rector carbon, or various compounds which are partial conductors in the dry state may be used, such as ball of copper, black oxide of manganese, peroxide of lead or similar semi-conducting materials, reduced to powder and moulded in buttons or disks; also finely divided metals, such as platinum, black gold, or disks of metal with a non-lathing surface having many points may be used. The circuits are arranged to bring into action one or more primary and secondary currents, and an induction coil or reeds, and switches, and a call, so that signals can be sent and received.

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ages transmitted in opposite directions over one line, as illustrated in the diagram Fig. 3.

A at station 1 is the carbon transmitter, and said instrument is included within the primary circuit of the induction coil D, E. D is the primary wire of the coil, and is wound on the outside of the secondary coil E. C is a switch, which, when moved to the right in contact with 15, places the transmitter A in the primary circuit containing the battery K and coil D. When the switch is in the center the primary circuit is open, and the apparatus is ready for the reception of a call signal. When the switch is turned to the left at 16 the instrument A is thrown out of circuit, and the battery only is connected to the primary coil D. The movement of the switch from 16 several times serves to open and close the primary circuit, and throw a powerful induced current into E, and then to the line. The polarized relay F, coil E, and receiving instrument B, are all placed in the main line wire at both stations. The powerful current thrown into the secondary coil and line by the movement of the switch C from 16 works the tongues of both polarized relays F in unison with the switch, the tongues closing against their contact points close a local circuit containing a call bell H.

The same battery K that is employed with the telephone is utilized to ring the bell. The connections for the transmitter A are from the battery K by wire 20 to 21, then through the telephone A to wire 22, and from 22 to 15, through the switch lever C to the primary coil D, and to wire 23, back to battery. This is the connection for transmitting and receiving telephonically. When not thus working the switch C is placed in the central position between 15 and 16. When in this position, if the switch of the distant station is moved to operate the call, the tongue of F closes the local circuit at 22, thence by wire 21 to battery K, and through K to wire 23, thence through the magnets of the bell coil to wire 26, and then through the tongue of the polarized relay. When the switch C is moved to work the distant call it is brought into contact with 16, and the current passes from K by wire 20 to 16, thence through C to the primary wire D, thence to 23, back to the battery K, and setting up a powerful induced current in the coil E and line. I will mention that it is not necessary to use a polarized relay, as an unpolarized relay of the ordinary character may be used as the current due to the opening of the primary circuit is much the strongest, but the lever of the unpolarized relay should be light and the spade very short. It is not even necessary to use the call bell H in many instances when the terminal is very quiet, as the sound given by the polarized relay itself is sufficient, or a small bell may be worked by the tongue of the relay itself. The tongue of the polarized relay should be biased, so that it will always be away from the point 22, except when moved by the signalling currents, so as to prevent short circuiting the battery K when transmitting telephonically. By employing two coils and a considerable resistance in the magnets upon the call bell, it is not essential to bias the tongue, but it may be made to respond to both positive and negative, a shunt from one coil being used to furnish current to the coil bell. The receiving instrument is provided with an electro-magnet, and an armature formed of an iron plate, diaphragm, and a hammer is attracted or repelled, so as to strike upon the diaphragm to form a call, and a stand is used to keep the telephone instruments in proper position for the call to act; these devices are shown in Fig. 4. A is the receiving instrument, provided with a diaphragm and a magnet for giving motion to it, the same as shown in British Letters Patent No. 2060, of 1877, granted to me. The magnet of the receiving instrument is included in the main line at a, or C is the primary coil; B, the secondary coil, which latter is included in the main line

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circuit; a is the sounder lever resting upon the diaphragm of A; X is a rack or stand for holding both the receiving and transmitting instruments when not in use. S is a switch; when it is turned to the point 1, the transmitter B is included in the primary circuit with coil C and battery Q, and the transmitter serves to increase and decrease its resistance when the diaphragm is vibrated by sound.

The transmitter is provided with a carbon lattice, through which the current passes, and it produces more or less resistance, according to the strength of the sound waves impinging on the diaphragm, as before described. When the switch lever S is moved to the point 2 the large wire U forms the primary coil, and it remains in this position for the reception of a call signal from the distant station; were the coil D left in circuit it would tend to weaken the signal call by its resistance to the passage of the current from the distant station. When the switch lever is at the point 3, the current from the battery Q passes only through the primary wire; by connecting and disconnecting the switch S from the latter a powerful induction wave is thrown into the line and set upon the distant receiver to attract and repel the lever c, and give the signal call. The induction coil C, D, may be made as in Fig. 5, in which the large wire U forms the primary coil, and the fine wire D wound around the same forms the secondary coil, the latter being placed in the main circuit, and the former in the local circuit, as heretofore explained.

Two or more vibrating instruments connected in the same circuit and operated by electro-magnets are thrown out of the circuit by a shunt, and act to give signals in two distant instrument provided with diaphragms. This arrangement is shown in Fig. 6, in which the connections at one end of the line are represented. Fig. 7 is a section of the resonant tube.

F and G are the vibrating reeds kept in continuous vibration by the electro-magnets R and S in a local circuit, provided with a suitable contact spring operated by the reel in the usual manner, but which are not shown here for clearness. M and N are electro-dynamic cells arranged and operated similar to those shown in Moreshead Patent No. 2060. The armatures of the electro-magnets are laminated. The vibration of one of the electrodes serves to increase and decrease the resistance of the electric current by causing the current to pass through a greater or less amount of water between the electrodes. L is the main battery in the main circuit, in which are the cells M, N. H and K are keys used for the purpose of line T, in which are the cells M, N. H and K are keys used for the purpose of stopping and starting the current between the electrodes. L is the main battery in the main circuit, in which are the cells M, N. H and K are keys used for the purpose of circulating the electro-dynamic cells X or M. The reeds F and G are tuned to give different tones, and several reeds, substantially the same as herein described, may be included in the same circuit, all being tuned differently. A and B are the receivers which are shunted by the resonant tubes. Upon the ends of the resonant tubes are iron or steel diaphragms, which act as the armatures of the electro-magnets R, E, and are facing them. X and Y are secondary tubes which slide within the tubes A & B like the tubes of a telescope. The object of the tubes is to allow of the lengthening or shortening of the column of air in the resonant tube, so as to bring it in unison to the particular note or tone which it is desired to hear. The iron diaphragms respond to all the tones with equal power, and are not so much means provided for strengthening or reinforcing one particular tone it would be very difficult for the operator to pick out the tone required, but by the use of the resonant tubes this difficulty is overcome, because the tone is given distinct when the armature is vibrated in harmony with the note of the tube.

The induction coils serve to throw into the line a powerful induced current, and in some instances I employ a battery connected with the line, and balanced so that

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the sound waves arrive at the ear horn or other resistance cause either the positive or negative of the battery to preponderate on the line. The induction coils and their arrangement in the electric circuits are shown in Figs. 9, 10, 11 and 12. In Fig. 9 the transmitter is provided with the diaphragm *e* and coil *f*, and the secondary circuit is connected to the primary coils *g* and *h*, as before described. 1, 2 and 3 are all connected in the "same circuit," in which also is included the disks 1, 2, carbon button *b*, and local battery *L*. The secondary or inner coils of 1, 2 and 3 are all connected together and are included in the main line circuit with the receiver and call bell. The impact of the induction coils is increased by the use of a large quantity of wire, and, according to their strength, subjects the ear horn to a greater or less resistance. The resistance of the secondary circuit will be varied owing to the small resistance of the local circuit and the power of the battery; a very slight change in the resistance of the circuit flows a powerful induction current into the secondary circuit, which passing over the line, will strike the diaphragm of the transmitter. 15

The effect of using more than one induction coil is to get a greater amount of wire nearer the inner cores, which are bundles of iron wire. In Fig. 10, the same kinds of coils are shown, but they are connected in the local circuit slightly different, being connected in the same manner as in Fig. 9, but the secondary circuit is divided into several coils, arranged for 20

different quantities. This brings more current from the battery, and a very slight change in the resistance in the carbon button of the transmitter causes a powerful induced current to circulate in the secondary coil and line. In Fig. 11 the same method of arrangement is shown, but the resistance of the diaphragm of the transmitter is increased by the use of a normal position its resistance is equal to *R* when no current passes in the primary coil of the inductorium, but the slightest change in the resistance of the carbon button *b* decreases the balance between the batteries, and a 25

current passes to the primary. In Fig. 8, a conducting induction coil is shown, the coil is formed of a spiral of wire, having a large surface to which the air is applied; the strips are wound into a spiral with no conducting material intervening, and to these strips the respective electric wires are connected. The current passes from end to end. One coil of wire is connected in the main line circuit and forms part of *g*, while the other is connected in the local circuit, the 30

induction coils and their arrangement in the electric circuits are sometimes arranged as in Fig. 13.

At station A the transmitter A is provided with the carbon button and disks afore-mentioned. B is the receiver, provided with an iron diaphragm opposite the cores of an electro-magnet, the same as in aforesaid Letters Patent, but an ear at the end of a flexible tube connected to the body of the receiver is shown at B. The transmitter A is provided with a switch, the principle of which is shown in Fig. 2, which when moved to the right is in contact with D places transmitter A in said primary circuit containing battery F and coil G. It also allows the line current to pass through receiver B, secondary coil H, switch point C, and transmitter A to ground. When the switch is placed to the left in contact with E the transmitter A is in direct connection with the primary coil of induction G, and the line current is cut off through the calling sounder D, switch point C, primary coil G, battery F, to the ground.

The batteries are so arranged at each end of the line that when both switches are placed to left on E they will act together instead of against each other, there being sufficient battery to work the calling sounders at each end of the line. At station B

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the calling sounder is replaced by a relay J'; this device I use when the line is too long for the sounder to operate distinctly, or when the call bell K, which is worked by points of relay J', is required to be placed at a distance from the other instruments. The bell K is placed in a local circuit with battery L.

5 Sometimes I employ a battery connected with the line and balanced so that the sound waves acting on the carbon or other resistance cause either the positive or negative of the battery to preponderate on the line. In Fig. 14 the polarity of the iron core of the induction coil D, E, is reversed at every vibration of the diaphragm c ; h, h' , are two carbon buttons, and the disks 1 and 2 are connected with the
10 batteries B, B', and primary coil D. When the diaphragm c moves forward h' sends a current in one direction, and when it goes backward h sends a current in the contrary direction.

When the air waves strike upon a vibrating plate or disk the change of pressure upon the carbon may be obtained from a thin strata of air intervening between the diaphragm and the platinum plate of the carbon. Fig. 15 shows a transmitter and the carbon button *b* and disks 1, 2, arranged so that the pressure on the carbon is obtained by the movement of the air between the diaphragm *c* and disk 1 as said diaphragm is vibrated.

A magneto-electric machine is sometimes used as the source of electric energy in place of a battery, and the telephone instrument placed in the Wheatstone bridge and resistance placed to balance the electric forces so that variation in the resistance in the telephone sends the current on the line. Fig. 16 represents the transmitting instrument sectionally, and also shows the circuit connections with the telephone in the Wheatstone bridge.

[illegible]

The induction coil H has its secondary coil included in the line circuit, and the primary coil is connected with a transmitting instrument T constructed and operating in a similar manner to the transmitter A, the local battery B being in the circuit through the carbon button and primary coil. The receiving instrument I,

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is provided with a diaphragm that is acted upon by the core of the induction coil B, and hence the induction coil is utilized and serves for receiving or transmitting telephonically. In Fig. 17 the balance of the similar batteries B, B', with opposite poles to line is obtained by the rheostat R that is of a resistance equal to that of the instrument A when at rest, and when the resistance of the carbon $\bar{c}$ is increased or decreased by the sonorous vibrations the current will pass upon the line either positive or negative, according to the resistance in A. In Fig. 18 a modification of the transmitter is shown. The plate $\bar{c}$ rests against a disk of fibrous substance $\bar{c}'$, such as silk, with a finely divided material, such as plumbago worked into its fibers. There may be several such disks, and the plate 2 is at the opposite side of these disks. There are edges that are turned over to receive the edges of the mouthpiece $\bar{h}$, and a spring $\bar{e}$ presses the plate $\bar{c}$ towards the disks of silk so as to hold them against 2. One conductor from an induction coil passes to 2 and the other to $\bar{c}$, and the slightest sonorous waves acting against $\bar{c}$ varies the resistance according to the pressure upon the fibrous material. Telephones in local circuits or shunts at way stations with induction coils in the main line are used for operating local telephones on the main line, as shown in Fig. 19.

A' and B' are magnets placed at way stations; A', A', are carbon transmitters, which serve to short circuit the magnets more or less, according to the vibrations of the diaphragms of said transmitters.

The sound vibrations act by leverage upon the carbon or other resistance to increase or lessen the motion as circumstances require. In Fig. 20 the carbon $\bar{h}$ is acted upon by the lever X upon the fulcrum $\bar{x}$, and said button is placed between the fulcrum of said lever and the point where the lever is acted upon by the diaphragm of the transmitter. In Fig. 21 the carbon button is acted upon by the outer end of the lever X.

In Fig. 22 the carbon button $\bar{h}$ is secured to the outer end of the lever X, and said button rests upon a button of carbon $\bar{x}'$ secured to the diaphragm of the transmitter.

The lever is weighted at $\bar{o}'$, and there is a spring at $\bar{o}'$ and adjusting rod by which the initial pressure of the carbon button $\bar{h}$ upon the button $\bar{x}'$ may be adjusted. There is a plate $\bar{h}'$ of mica or other light material secured to the lever X, and upon this plate the sound waves strike. The transmitter is shown as upon a resonant box $\bar{c}'$ with an opening in the top of the box immediately beneath the diaphragm $\bar{c}$. The slightest vibration or jar given to the apparatus, such as that resulting from walking about a room, or from the articulate speech, or sound vibrations, varying the pressure of $\bar{h}$ and $\bar{x}'$ upon each other, and in so doing the electric condition of a circuit passing through X, $\bar{h}$, $\bar{x}'$ and $\bar{c}$, and wires 7 and 8 is varied, and a corresponding response occurs in a distant receiving telephone.

A secondary battery is sometimes employed in place of condenser, as in Fig. 23; this is used with a Wallaston electrode. This arrangement allows the first part of a wave to be strong, followed by a weakening, due to resistance placed in circuit by polarization of the small point. This extra resistance allows more current to pass to secondary coil. A thermal battery similar to that shown in my Letters Patent aforesaid may be used as the source of electric energy.

When the electric current is made to pass through water or an electrolyte solution of the diaphragm acts upon a valve or off to vary the volume of liquid where the current passes, and effect a rise and fall of electric tension.

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Fig. 24 is a vertical longitudinal section of a transmitter fitted with this improvement; and Fig. 25 is a cross section of the line $\bar{x}$.

B is a cylinder of insulating material divided by a partition B' into two compartments or cells filled with a conducting fluid. In each cell is an electrode of platinum carbon, or other conductor, one of which is connected to the line wire, and the other to the battery and earth. The top portion of the partition B' is slightly hollow, leaving a passageway 2 for the fluid and current to circulate from one cell to the next. Rounding upon the face of the cylinder is a flexible head of mica, rubber, or other non-conducting material $\bar{c}$ impervious to the fluid, and over this is secured a cap $\bar{e}$ provided with a slot. When the cap $\bar{e}$ is securely fastened to the cylinder the diaphragm prevents any of the fluid circulating from one cell to the other, except through the small aperture at 2 made by the curve on the end of the partition B'. $\bar{h}$ is a box with a mouth-piece A, and at one side of the box is secured the diaphragm $\bar{c}$, and upon the diaphragm is a piece of cork $\bar{c}'$, which extends outward from B, and through the slot in the cap $\bar{e}$ on the head of the cylinder B, and comes in contact with the mica or rubber flexible head $\bar{c}$, to which it may be secured by a cement, although this is not actually necessary. The operation is as follows:—When the diaphragm $\bar{c}$ is properly adjusted to the diaphragm in the cylinder B, the space for the circulation of the fluid from one cell to the other is very narrow. If, now, the diaphragm is set in vibration by a sound, the passage-way is increased and decreased in size at every vibration, thus increasing and decreasing the resistance to the passage of the current from one cell to the other, owing to the alteration in the size of the liquid conductor. If the amplitude of the diaphragm is very great, the space is nearly, if not altogether, closed at the forward movement, and widened to its fullest extent by the backward motion; and if the amplitude is small only a slight increase and decrease in size of the aperture takes place, according to the size of the opening, so there will be more or less resistance to the current passing through the liquid at this point, and there will be a corresponding rise and fall of the electric tension on the line at this point. It is obvious that with a mobile fluid all electric tension on the line at this point, and there will be a corresponding rise and fall of the electric tension. In Fig. 25 the cylinder B is represented as standing vertically instead of horizontally, as in Fig. 24, which permits of the diaphragm changing of electric tension. In Fig. 26 I have represented several narrow slots $\bar{c}$ and $\bar{c}'$ being dispensed with. In Fig. 27 I have represented several narrow slots in the partition B' between the cells, and this striped metal $\bar{c}'$ from the diaphragm $\bar{c}$, running down at the side of the partition, and also slotted, but the slots in the normal position do not correspond; hence, by the vibration of the diaphragm, the openings are increased or lessened, and the resistance to the electric current increased or decreased.

Fig. 28 shows the partition B' arranged horizontally, the passageway from one cell to the other being controlled by a valve or plunger $\bar{c}$, arranged at an aperture through the partition. In Fig. 29 the passageway is between two independent tubes by means of a flexible tube $\bar{c}$, and the opening is increased or lessened by the cells by means of a flexible tube $\bar{c}$ that passes upon the flexible movement of the diaphragm acting through a finger $\bar{c}$ that presses upon the flexible tube. I will mention that mercury may be used instead of an electrolyte, or a porous material, such as paper, may serve to connect the cells together. $\bar{c}$ represents a piece of porous material, such as paper or muslin, and the ends pass into liquid in the cells, so as to be kept moist by capillary attraction; and adjacent to this is a porous $\bar{p}$, connected to the diaphragm or other vibrating body, so as to be moved by the same, and press with more or less force upon the moistened strip.

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and interrupt the passage of electricity more or less, according to the amplitude of vibration.

A Dulcree dry pile is combined with a diaphragm at each terminal for transmitting and receiving sound; this is shown in Fig. 31. D is a tube containing a Dulcree dry pile of many pairs; one end is connected to earth, the other to a disk a' , facing a metallic diaphragm c connected to the line and distant station, where it connects to a precisely similar apparatus. The movement of the diaphragm to and from the disk causes a rise and fall of electric tension on the line.

An electrophoretic, similarly combined, is sometimes employed for the same purpose, as in Fig. 32. The base of metal is connected to earth. Upon said disk there is a disk of sulphur 2, charged with electricity, that faces the metallic diaphragm 3, which latter is connected to the line. The rise and fall of tension on the line is produced by the movement of the diaphragm to and from the sulphur disk.

Calls are combined with the telephone, so as to attract attention to the instrument. These calls are operated by pendulums, forks, or reeds, which set up magneto-electric currents when vibrated, and from these a bell or call receives its movement from the distant station.

In Fig. 33 the tuning fork X is vibrated by the electro-magnet α^1 , by waves set in motion by a similar fork at the distant station: when the fork has received considerable vibration it strikes the lever α^2 , which latter releases a clock movement that gives the alarm.

men than 20 ft. In Fig. 24 the fork N strikes the bell and gives the alarm. In Fig. 25 the fork N does a local circuit, and the bell is rung by a magnet and bell battery. In Fig. 26 a polarized relay is used with its tongue centered by a tightly drawn wire. This tongue does the local circuit containing a magneto call-bell. In Fig. 27 two magneto pendulums N serve to give the call; the signaler lowers his bell and gives the pendulum a large swing by hand, which soon sets the pendulum in motion at the distant station by the currents which it sets up in the magnets n and n' , which are polarized.

The receiving portions of the telephone are of a character adapted to respond to the electric pulsations from the transmitting telephones aforesaid. Sometimes there are two or more receiving diaphragms to one air chamber to augment the sound.

Fig. 38 shows a receiver provided with two metallic diaphragms *d* and two electro-magnets *d'* through which the line current passes. Fig. 39 shows the armature diaphragms *d* arranged edgeways to the opening in the mouth-piece, with magnets opposite said diaphragms. This arrangement permits of the reception of signals, but prevents the transmission of any by magneto-induction. Fig. 40 shows several electro-magnets, each provided with a diaphragm, all included in one case, and all in the main line circuit; the sounds received are augmented.

Dampers may be employed upon the diaphragm of the receiving and transmitting instruments to prevent false vibrations. These may be the same as those shown and described in my British Letters Patent, No. 1644 of 1878.

A diaphragm connected directly upon the induction coil will respond to the electric waves, and give audible sounds. This device is shown in Fig. 41.

In place of flexible wires for the telephone connections, wires with universal joints are preferable. Long funnels may be used with the telephonic receiver to increase the volume of sound.

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[illegible]

In Fig. 41 the diaphragm at 12 is provided with a pin valve that allows the compressed air or other fluid in the pipe 13 to pass to the pipe 14 and diaphragm 15. This diaphragm 15 is of iron and faces the core of a polarized magnet, and it receives no movement from the compressed air than it would if acted upon by the voice alone. The diaphragm 15 vibrates in harmony with the diaphragm 12, when the latter is vibrated by the sound vibrations of the human voice or otherwise.

In Fig. 45 the diaphragm d and mouthpiece is at the side of a closed box. Within this box there is a continuously rotating cylinder of chalk C , on the surface of which rests the end of a spring arm A secured to the diaphragm. The chalk has combined with it an alkali or other conducting electrolyte, and is kept moist by water.

By water.

One wire is connected to the chalk cylinder and the other to the spring or diaphragm. When the current passes to the cylinder of chalk the friction of the cylinder upon the chalk causes the diaphragm to be drawn inward, but when an electric wave passes through such cylinder the friction between the chalk and the spring is destroyed and the diaphragm moves outwardly, to be again drawn inwardly when the current ceases. By this means the diaphragm will be utilized in harmony with the diaphragm of the distant transmitting instrument, and a sponge reproduces the sound that acted upon the diaphragm of the chalk cylinder, which box and cell of water is placed within the box containing the chalk cylinder, so that the cylinder should be airtight. The use of a chalk cylinder is an improvement on the device

U. S. PATENT OFFICE, 1877.

Fig. 46 shows a tube containing mercury, in which is a float in water above the mercury; the float is connected to the diaphragm *d*. The diaphragm will be vibrated by the movement of the mercury, caused by the heat of the current passing through the same. Fig. 47 shows a transmitter made up as a small tube condenser formed of disks secured to the diaphragm, and provided with an adjusting screw *N* for tightening the disks. The impact of the sound waves upon the diaphragm produces the sound waves.

What I claim as my invention and desire to secure by Letters Patent is,—

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First. An electric tension regulator made of carbon or other flexibly divided conducting material consolidated by pressure, substantially as and for the purposes set forth.

Second. The carbon button *b* between the platinum disks 1 and 2 in combination with the adjusting screw *f*, diaphragm *c*, and mouth-piece, substantially as specified.

Third. The combination of transmitter A, coils D, E, switch C, polarized relay P, bell H, battery K, and circuits, arranged and operating substantially as herein set forth and as shown in Fig. 3.

Fourth. In combination with a telephonic and the primary circuit of an induction coil the button of lamp-black carbon, prepared as set forth and placed in the primary circuit, substantially as and for the purposes set forth and as shown in Fig. 3.

Fifth. In combination with a receiving telephone instrument, having a diaphragm and electro-magnet, a swinging lever placed with its moving end in contact with the receiving diaphragm, and a switch or key for increasing the electric current and operating the lever as a sounder or call upon the diaphragm, substantially as set forth and shown in Fig. 4.

Sixth. In combination with the telephone transmitter B and receiver A the induction coil C, D, battery Q, local circuit, switch S, and circuit connections, substantially as set forth and as shown in Fig. 4.

Seventh. In combination with the main line circuit and local circuit and the telephonic instrument the induction coil composed of two wires, the largest of which is surrounded by a finer insulated wire wound helically, the two being then wound into a helix to form the induction coil, substantially as shown, and described in connection with Fig. 5.

Eighth. The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for rendering audible acoustic vibrations, substantially as described, and shown in Fig. 5.

Ninth. The combination with a diaphragm vibrated by an electro-magnet of a resonant tube variable in its length, so as to adjust the column of air to the tone of the transmitting instrument, substantially as shown and described with reference to Fig. 7.

Tenth. The combination with a vibrating reed and electrolytic cells placed in the electric circuit of a key placed in a shunt circuit, substantially as shown in Fig. 6.

Eleventh. The condensing coil 1, Fig. 8, arranged in the electric circuit, and operating substantially as described.

Twelfth. The induction coils 1, 2, 3, Fig. 9, electric circuits, and carbon transmitter, arranged and operating substantially as and for the purposes set forth.

Thirteenth. The induction coils and electric circuits, and carbon transmitter, arranged and operating as described, and shown in Fig. 10.

Fourteenth. Two or more primary coils wound upon one secondary coil, as in Fig. 11, in combination with the electric circuits and carbon transmitter, substantially as specified.

Fifteenth. The induction coil 1, resistance R, batteries B, electric circuits, and carbon transmitter, arranged and operating as described, and as shown in Fig. 12.

Sixteenth. The induction coils G, H, telephonic instruments A, B, switch C, key

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and sounder, arranged and operating in the electric circuits, substantially as described, and as shown in Fig. 13.

Seventeenth. The carbon transmitters A, E, and induction coil D, E, and diaphragm *c*, Fig. 14, in combination with the batteries B, K, and electric circuits, substantially as and for the purposes set forth.

Eighteenth. The carbon button *b* and disks 1, 2, in combination with the diaphragm *c* of the speaking tube, arranged and operating as shown in and described, with reference to Fig. 15.

Nineteenth. The combination with an induction coil of a diaphragm that is acted upon by such induction coil, and gives out sonorous vibrations, substantially as described and shown in Fig. 16.

Twentieth. In combination with the balanced circuits shown in Fig. 16 a telephonic instrument included in one circuit, and acting to vary the electric condition of the line by the resistance that is controlled by the sound vibration, substantially as set forth.

Twenty-first. A transmitting telephone containing a variable resistance in the electric circuit and a body acting by inertia, to vary the resistance in proportion to the sound vibrations, substantially as described in connection with Fig. 16.

Twenty-second. The induction coils in local circuits or shunts at way stations in combination with the telephonic instruments, also in such circuits, substantially as and for the purposes described in and as shown in Fig. 19.

Twenty-third. The carbon transmitter K, lever N, and diaphragm *c*, arranged as shown in Figs. 20 and 21.

Twenty-fourth. The combination with a resonant case *e*, Fig. 22, of the lever X, diaphragm *c*, carbons *k* and *k'*, disk *f*, and circuit connections, substantially as set forth.

Twenty-fifth. The apparatus shown in Fig. 22, capable of receiving atmospheric and other vibrations, and transmitting the same electrically to a receiving telephone through a circuit wire and connections, substantially as set forth.

Twenty-sixth. The carbon transmitter in a local circuit, containing a secondary battery, in combination with the induction coil D, E, connected in the main and local circuits, as illustrated in Fig. 23.

Twenty-seventh. In an acoustic telegraph apparatus, the combination of a stationary electrodes immersed in two cells, a conducting fluid in said cells, and a fluid connection between such cells and mechanism actuated by a sound vibrated body for varying the dimensions of such liquid connection and the conductivity of the same, substantially as set forth.

Twenty-eighth. The dry pile battery, arranged in connection with the telephonic instrument, as illustrated in Fig. 24.

Twenty-ninth. The electrophons arranged in connection with the telephonic instruments, as illustrated in Fig. 32.

Thirtieth. A telephonic call consisting of a reed or tuning fork vibrated by an electro-magnet, and acting to strike a bell, release mechanism that sounds an alarm, or open and close a local circuit in which is an alarm or call, as illustrated in Figs. 33, 34 and 35.

Thirty-first. The polarized relay in a telephonic electric circuit, and acting to open and close a local circuit in which is a magneto call bell.

Thirty-second. In a telephonic electric circuit, a pseudum vibrated by a polarized electro-magnet, and striking a call or bell, as illustrated in Fig. 37.

Thirty-third. A telephonic receiving instrument containing two or more notes

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diaphragms and two or more electro-magnets, as illustrated in Figs. 38, 39 and 40.

Thirty-fourth. The induction coil, Fig. 41, with its core facing the diaphragm of the telephone, substantially as and for the purposes set forth.

Thirty-fifth. The combination in an electric circuit of one or more disks or pieces of carbon or equivalent material operated upon by pressure to vary the resistance in the circuit, and indicate by a galvanometer or other scale, differences of weight, pressure, or electric condition.

Thirty-sixth. The diaphragm 12, Fig. 44, controlling a source of compressed fluid, which latter acts upon the diaphragm 15, to give greater vibration thereto than if acted upon by the voice or sound waves alone, as specified.

Thirty-seventh. In combination with the diaphragm of and arm of, Fig. 45, the continuously rotating cylinder of chalk inscribed with a disjunctive salt, and operating substantially as described.

Thirty-eighth. The diaphragm of the telephonic instrument connected to a float in a tube containing mercury and water, said diaphragm being vibrated by the motion of the mercury, substantially as described in connection with Fig. 46.

Thirty-ninth. The telephonic transmitter, Fig. 47, made with a mica condenser, formed of discs, secured to the diaphragm, and provided with an adjusting screw for tightening the discs, as specified.

In witness whereof, I, the said Thomas Alva Edison, have hereto set my hand and seal, this 27th of November, A. D. 1878.

THOMAS ALVA EDISON. [L. S.]

WITNESSES:

CHARLES H. SMITH, 76 Chambers Street, New York.

Geo. T. PINSKEY, " " " "

ADAMS, Nov. 25, 1878.
THOMAS A. EDISON.
Geo. T. PINSKEY.

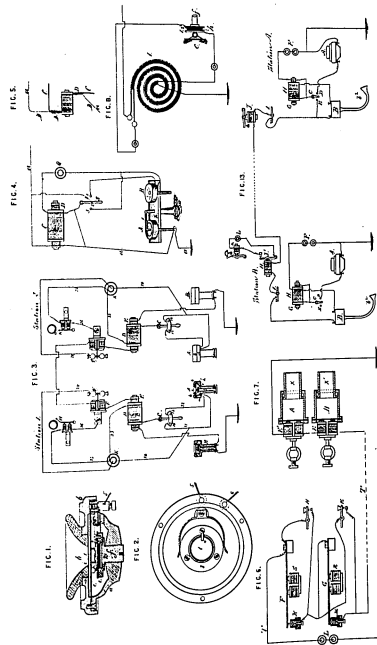
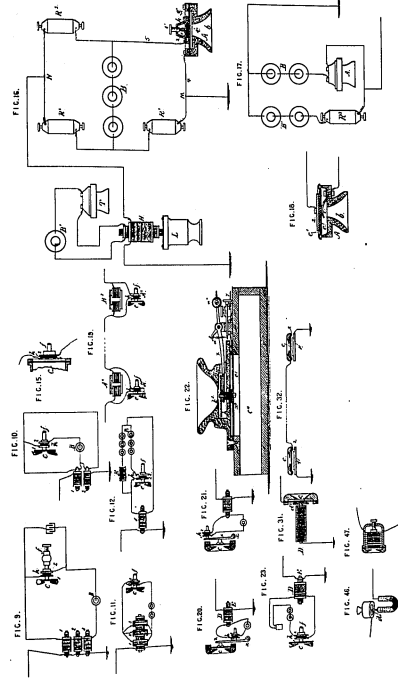


FIG. 1. SECTIONAL VIEW OF THE MAIN
ASSEMBLY OF THE APPARATUS
(1/2" Scale)



U.S. PATENT OFFICE
DIVISION OF PATENT INQUIRY
WASHINGTON, D.C. 20540



THIS AGREEMENT, entered into this fourteenth day of December, in the year One Thousand Eight Hundred and Seventy-five, by and between the WESTERN UNION TELEGRAPH COMPANY, party of the first part, and THOMAS A. EDISON, of the City of Newark, County of Essex and State of New Jersey, party of the second part, *Witnesseth*.

The said Edison agrees to invent, construct, and place in practical operation upon the lines of the said company, a system or method for telegraphing by vibrations, of the kind referred to, and more particularly described under the head of "The Acoustic Telegraph," in a work called the "Wonders of Electricity," published by Charles Scribner & Co., in 1872, whereby, not less than five or more distinct and separate messages can be transmitted on a single wire in opposite directions at one and the same time without interference with each other, said system to be hereafter called the Acoustic Telegraph.

It is further agreed by the said Edison that he shall cause to be made from time to time "Circuits" describing his ideas and experiments, to be filed in the Patent Office at Washington, copies of which are to be delivered to said company as soon as practicable, after each part of such system shall be invented or discovered, accompanied by assignments of the invention or discovery so described to the Western Union Telegraph Company as sole assignee, with directions that the patent shall issue to said Western Union Telegraph Company when issued, and will also sign and deliver applications for letters patent in due form, to be used by the attorneys hereinafter named at their discretion.

The said Edison shall from time to time construct all such models as may be convenient or necessary for the purposes of such applications, or such of them as in the opinion of William Otton, President of the Company, are necessary to protect such system of Acoustic Telegraphy, or any part thereof.

The said Edison shall, also, from time to time, upon the request of the Western Union Telegraph Company, make and sign such new and different applications as may become necessary or desirable for each invention, discovery or improvement made by him in said system of Acoustic Telegraphy; and in like manner new assignments of the subject matter of each application, with like request for issue of Letters Patent to said Company; it being the intent and purpose of the said Edison, for the consideration herein-after named and provided, to secure to the Western Union Telegraph Company the sole title and monopoly in the United States of all inventions or discoveries made, or to be made by him, which are necessary to perfect Acoustic Telegraphy. For the purpose of securing more fully the object herein stated, the said Edison shall also nominate and appoint Grosvenor P. Lowrey, his attorney irrevocable, with power of substitution and revocation, to prosecute all applications in the Patent Office respecting such applications; all and to represent said Edison in all matters respecting such applications here-in, and all costs for legal service to be at the charge of the Western Union Telegraph Company.

The said Edison further agrees to use the utmost diligence in carrying forward his experiments for perfecting and introducing the said system of Acoustic Telegraphy upon the lines of the said Telegraph Company.

The said Company agrees to furnish full facilities in all its offices and shops and over all its wires for testing such inventions, and to pay all the actual expenses of experimentation, not exceeding two hundred dollars per week, to be accounted for by vouchers until such invention has been completed to the satisfaction of William Orton, representing the Company, and in satisfactory operation upon its lines. But such weekly payments may be discontinued at any time at the option of the said Orton, if in his opinion the results obtained at the time do not warrant such expenditures, or if he disapproves of the method of dissuading such monies.

All necessary expenses for patent sales and solicitor's fees for obtaining Letters Patent in the United States for said Acoustic Telegraph, are to be paid by the Company.

For and in consideration of the stipitation heretofore by Edison and of the performing introducing and assigning such inventions and due performance of the provisions of this contract, the company agrees, in addition to the payment of the charges and expenses above provided for, to pay to said Edison upon the completion of a satisfactory system of acoustic telegraphy, and the issue of Letters Patent therefor to it, as herein stipulated, a sum not less than six thousand dollars, and a further sum, the amount and the manner of payment of which is to be left to the fairness and judgment of the said Orton, provided, however, that in case of refusal or failure by said Orton to fix and determine such price within three months after demand, by said Edison, the price shall be fixed by a Board of Arbitrators, consisting of three skilled persons, one to be chosen by each party hereto, and the third by such two, and whose award shall be final. The said Edison shall have the right, in like manner to appeal to arbitration, if in his opinion any price fixed by said Orton is grossly inadequate or unfair, but in all cases the arbitrators, in forming their judgment of value, shall consider only the commercial values of such invention to the company, in view of its existing facilities, means of business and also the cost of applying and economy in using the same, in comparison with any other method of telegraphy known at the time, as well as the expenditures already made by the company in respect of Acoustic Telegraphy. Upon these and all such consideration as ought to control the company acting as a purchaser, the arbitrators shall decide what further sum, if any, shall be paid to the said Edison. In case the company shall be dissatisfied with the award of any board of arbitrators, it may discharge itself from obligation to pay the same, by offering to re-assign to Edison his legal representatives or assigns, the subject matter for which the award was made, on receiving repayment of the sum not including expenses formerly paid thereon, and by making such re-assignment, on receiving such repayment.

It is also agreed that while experimenting upon the subject of Acoustic Telegraphy, the said Edison shall not make, invent, or operate any system or apparatus for telegraphy for any other company opposed to or competing with the Western Union Company. Provided, however, that this period shall not continue for more than one year.

It is also agreed that if said Edison shall, at any time hereafter make or discover any process, device, instrument or method which is an improvement upon any of the processes, devices or apparatus used in Acoustic Telegraphy, and covered or intended to be covered by this agreement, assignments therefor, and of all letters patent thereon shall be immediately, or as soon as practicable, and as above provided, made to William Orton, personally, to be by him held in trust, subject to a satisfactory or legal adjustment of price, in the same manner as heretofore provided. The said Edison shall, in like manner, through an attorney, satisfactory to said Orton, file caveats and applications, and prosecute the same in good faith, but at the expense of said Orton.

In witness whereof the said party of the first part has caused its common seal to be hereunto affixed, and its corporate name to be hereunto subscribed by the hand of its President, and the said party of the second, part has hereunto set his hand and seal, the day and year first above written.

THE WESTERN UNION TEL. CO.

By WILLIAM ORTON, President.

(Signed)

(Signed)

THOS. A. EDISON.

(Signed) A. R. BREWER,

Secretary.

(SEAL)

WITNESSES:

(Signed)

NORMAN C. MILLER,

GEORGE F. FARRAR.

This Memorandum of Agreement, entered into this twenty-second day of March, 1877, by and between the Western Union Telegraph Company, of New York and Thomas A. Edison, of Menlo Park, Middlesex County, New Jersey. *Witnesseth*:

WHEREAS, The said Edison, being the owner of an experimental laboratory at Menlo Park, New Jersey, provided with all the necessary facilities for perfecting new inventions applicable to the business of the said Telegraph Company, and being himself an expert in devising and perfecting such new inventions, is desirous of obtaining the aid and cooperation of the Telegraph Company, as hereinafter provided.

AND WHEREAS, The Telegraph Company is desirous of securing for its benefit the skill and experience of said Edison, and the sole right within the United States to all his inventions and improvements capable to be used on land lines of telegraph, or upon cables within the United States which may be made during the period covered by the agreement. Therefore, be it agreed,

Provided, This agreement is to continue for five years from the date hereof, unless sooner terminated, as hereinafter provided. The Company will assume a portion of the cost of experimenting with and producing such inventions and improvements, and will pay to the said Edison, in aid of such experimentation, subject to the provisions hereinafter stated, the sum of \$ * * * per week, during the period covered by this contract, the same to be used by the said Edison in payment of laboratory expenses incurred in perfecting inventions applicable to land lines of telegraph or cables, within the United States. * * * *Yield*: This agreement shall not be construed to apply to any improvements upon the system of chemical telegraphy, sometimes called automatic or fast telegraphy, and shall take effect from March 1st, 1877.

In Witness whereof, The parties to these presents have hereunto set their hands and seals, the day and year first above written.

THE WESTERN UNION TEL. CO.,
By WILLIAM ORIN, N.

President.

THOMAS A. EDISON.

A. R. BROWER,

Secretary.

SEAL
W. UNION

THIS AGREEMENT, made the thirty-first day of May, in the year one thousand eight hundred and seventy-eight, by and between THE WESTERN UNION TELEGRAPH COMPANY, party of the first part, and THOMAS A. EDISON, of Menlo Park in the State of New Jersey, party of the second part. *Witnesseth*:

First: *Witnesseth*, in performance of an agreement made between the parties hereto, and dated March 22d, 1877, Edison has made certain inventions and improvements in Speaking Telephones, which are more particularly described as follows:

1. An improvement in Speaking Telegraphs, No. 129, as fully set forth and shown in specification, dated April 18, 1877, and assigned to the Company by instrument, dated April 18, 1877, recorded in U. S. Patent Office in Liber O, 21, page 479 of Transfers of Patents.

2. An improvement in Speaking Telegraphs, No. 135, as fully set forth and shown in specification, dated July 10th, 1877, and assigned to the Company by instrument, dated July 16, 1877, recorded in U. S. Patent Office in Liber A, 22, page 131 of Transfers of Patents.

3. An improvement in Speaking Telegraphs, No. 126, as fully set forth and shown in specification, dated July 16, 1877, and assigned to the Company by instrument, dated July 16, 1877, recorded in U. S. Patent Office in Liber A, 22, page 133 of Transfers of Patents.

4. An improvement in Speaking Telegraphs, No. 143, as fully set forth and shown in specification, dated August 16, 1877, and assigned to the Company by instrument, dated August 16, 1877, recorded in U. S. Patent Office, in Liber A, 22, page 266 of Transfers of Patents.

5. An improvement in Speaking Telegraphs, No. 144, as fully set forth and shown in specification, dated August 21, 1877, and assigned to the Company by instrument, dated August 21, 1877, recorded in U. S. Patent Office, in Liber V, 21, page 62 of Transfers of Patents.

6. An improvement in Speaking Telegraphs, No. 116, as fully set forth and shown in specification, dated December 8, 1877, and assigned to the Company by instrument, dated December 8, 1877, recorded in U. S. Patent Office in Liber M, 22, page 36 of Transfers of Patents.

7. An improvement in speaking telegraphs, No. 147, as fully set forth and shown in specification dated December 8, 1877, and assigned to the company by instrument dated December 8, 1877, recorded in U. S. Patent Office in Liber, M, 22, page 37 of the Transfers of Patents.

8. An improvement in telegraph calls, No. 152, as fully set forth and shown in specification dated February 28, 1878, and assigned to the company by instrument dated February 28, 1878, recorded in U. S. Patent Office, in Liber, U, 22, page of Transfers of Patents.

9. An improvement in speaking telegraphs, No. 141, as fully set forth and shown in specification dated July 26th, 1877, and assigned to the company by instrument dated February 28, 1878, recorded in U. S. Patent Office, in Liber, U, 22, page 290 of Transfers of Patents.

10. An improvement in speaking telegraphs, No. 151, as fully set forth and shown in specification dated February 28, 1878, and assigned to the company by instrument dated February 28, 1878, recorded in U. S. Patent Office, in Liber, V, 22, page 31 of Transfers of Patents, for which inventions and

improvements application for Letters Patent of the United States are now pending in the cases designated as numbers 136, 141 and 144, and such Letters Patent have been allowed for those described in cases numbers 135, 136, 143, 146, 147, 151 and 152.

THIRD. And whereas, in performance of an agreement made between the parties hereto, dated December 14, 1875, Edison has made certain inventions and improvements in acoustic telegraphy, being those described in Letters Patent of the United States, issued to the company, upon his applications, and numbered severally 182,295, 185,507, 183,329, 180,087, 179,088, 180,880 and 200,003, and also those more fully described in applications for patents now pending in the Patent Office, as follows, to-wit:

An improvement in Acoustic Telegraphs, No. 132, as fully set forth and shown in specification dated May 8, 1877, and assigned to the Company by instrument dated February 25, 1878, recorded in U. S. Patent Office in Liber O, 22, page 253, of Transfers of Patents.

An improvement in Acoustic Telegraphs, No. 145, as fully set forth and shown in specification dated December 8, 1877, and assigned to the Company by instrument dated December 8, 1877, recorded in U. S. Patent Office in Liber M, 22, page 35, of Transfers of Patents.

An improvement in Acoustic Telegraphs, No. 148, as fully set forth and shown in specification dated December 15, 1877, and assigned to the Company by instrument dated December 15, 1877, recorded in U. S. Patent Office in Liber W, 22, page 129, of Transfers of Patents.

An improvement in Acoustic Telegraphs, No. 150, as fully set forth and shown in specification dated February 12, 1878, recorded in U. S. Patent Office in Liber U, 22, page 172, of Transfers of Patents.

An improvement in Acoustic Telegraphs, No. 123, as fully set forth and shown in specification dated August 18, 1879, and filed in U. S. Patent Office.

— of which invention there has been no assignment.

An improvement in Acoustic Telegraphs, No. 125, as fully set forth and shown in specification dated August 26, 1879, and filed in U. S. Patent Office.

— of which invention there has been no assignment.

FIFTH. Edison sells, and assigns, and hereby transfers and conveys to the Company, all his rights, title and interest in and to all the inventions and improvements mentioned in the first clause herof, and in and to all his inventions and improvements in Speaking Telephones as they in fact exist at the date of this instrument, even if they are not fully described in the specifications and assignments there recited and in all letters patent of the United States for them or any of them, and further hereby agrees to sell and assign to the Company all new inventions in Speaking Telephones which he may make before January 1, 1879, and also all improvements which he may make before January 1, 1879, upon any of the inventions and improvements described in this clause.

SIXTH. Edison agrees that, if at any time during the period of seventeen years fixed by the sixth clause herof, he invents any Speaking Telephone, or other apparatus whereby oral communication is conveyed over telegraphic

circuits, which, from its being based on a different principle, or from being constructed mechanically different from any of the inventions aforesaid or referred to in the fifth clause herof, shall avoid any patent for any of said inventions or improvements, or which shall be capable of being used without infringement of any such patent; provided, however, that such invention different in principle or mechanical construction, shall have no such practical advantage over the invention covered by such patent as to make the new invention of any greater value than the invention already covered by such patent, he will, from time to time, as such invention different in principle or construction, as aforesaid, and being without such practical advantage, as aforesaid, over the inventions covered by the fifth clause herof may be made by him, assign and convey all his right, title and interest in them and to the patents of the United States therefore to the Company.

In witness whereof the said Western Union Telegraph Company has hereto set its corporate seal and caused its name to be signed by its acting President, and attested by its Secretary, and the said Thomas A. Edison has hereto set his hand and seal the day and year first above written.

Signed, sealed and delivered
in the presence of
Notary.—The words "ninth and tenth,"
interlined between the 28th and
29th lines on 7th page, and the
words "the invention," interlined
between the 24th and 25th lines on
8th page, all before execution.

Wm. R. ROBERTS.

The Western Union Telegraph Co.
by Norvin Green, Pres't.

THOMAS A. EDISON.

Attest.

A. R. BREWSTER,
Sec'y.

WESTERN UNION TELEGRAPH CO.
SECRETARY'S OFFICE

MEMORANDUM.

August 31 1877.

Wm Oulton.

I shall have the other pair of telephones over tomorrow. I think that will make the 3 pair. The new pair will be about as perfect in design, convenience and perfection of articulation as I shall probably be able to make them. If you are in no haste ^{for any more} their 3 pair can remain on test while I go ahead with the "entire" which shall be more telephonic or the Edison!

Thomas A. Edison /
August 31, 1877
Telephone.

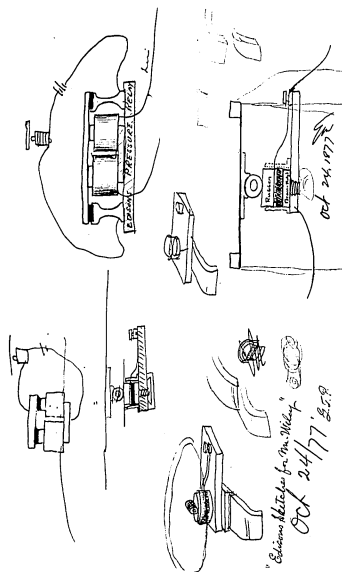
Oct 15-1897

Wm. Orton.

I have today delivered six telephones with
 call bells. I deliver two tomorrow, I
 believe these will prove satisfactory.
 The rubber I use is pure rubber, the same
 as that used in the valves of motor cars,
 valves in gas-bone gas machines, I have
 a diaphragm stretched on a Helmholtz
 resonator made in September 1895 used
 in acoustic, it has not altered, I think
 no trouble will be had with it, as it is
 neither exposed to the sun or to oils,
 Murray makes the slight alteration
~~for~~ or rather addition an excise for his
 delay whereas he has not today
 obtained his boxes or double connecting
 cord. I shall hurry him up,

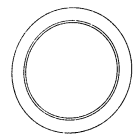
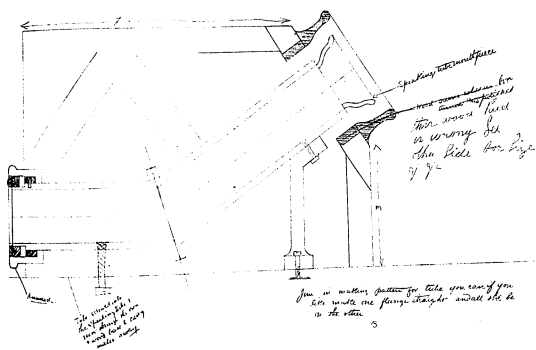
J A Edson

PS Johnson yet perfect even now with the
 rubber and no more adjustment is required
 whereas before there was momentarily necessary



Section of Machinery Instrument 4400
Ch. M. B. 1899

"Machinery Calculated Drawing of
 Instrument 130-14
St. F. P. M. 1899
Notation

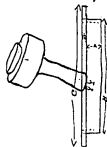


Speaking Telegraph

Oct 8th 1877
Chas. B. Balch

Alteration and Addition to be made on first here -
made by J. T. Murray

1 Ring for Rubber Diaphragm



Flange to be to the rubber when in place
A should be so wide that the face of base rests
in almost ~~flat~~ with the face of base rests
the rubber is moved down ~~from~~ when a straight
edge is put across you can just see light through
it when the rubber is

2500,
2000,
800,



The self hidden must be trans like model
with a 5/8" screw, screws into slide instead
of piece B like this
A is thin piece
B is rubber piece

The bridge must have rubber fast tender it
thrust against a spring the fluffholder to incl away
from face of diaphragm when it is back

"Murray Exhibit Oct 8th 1877"
Chas. B. Balch
Notary.

2 feet 3/4 Rubber

Alterations-

- 1 Body part of telephone must be too lower than ring
- 2 Pillars must be faced off straight
- 3 Soft hand screws must be shortened
- 4 Bridge must be slotted and feather soldered in instead of 64 screws
- 5 Bridge must have a rubber insulation for connection
- 6 The eighth hole in ring is to be drilled through + counter sunk
- 7 Fly holder to be altered to model
- 8 Sore + washer for insulation on bridge
- 9 Bridge slotted under + supports in
- 10 Screws for bridge larger head

Oct 29/77

Left Per Order of
 "Exhibit ~~Exhibit~~ ^{Exhibit} T A Edison
 alterations Oct. 29, 1897"
 Geo. T. Buckner
 Patent

[From *Journal of the Telegraph*, July 10th, 1877.—New York.]

TELEPHONIC INVENTIONS.

DESCRIPTION OF THE INVENTIONS OF GALEY, BELL AND EDISON.

The attention of electricians having been of late years called to the transmission of musical tones or sounds between distant points by means of electricity, a number of our most noted inventors have made experiments to demonstrate what could be done in that direction, and what, if any, practical value such acoustic telegraphy possessed for the purposes of ordinary commercial telegraphy. Among these inventors there have obtained results of interest to the scientist and the public generally. They are Thomas A. Edison, of Menlo Park, N. J.; Elias Gray, of Chicago, and A. G. Bell, of Boston. The original idea of each was to devise a system of multiplex transmission of dispatches by means of a Morse apparatus in common use, the *audios apparatus* being in one tuning forks or other vibratory apparatus for generating a number of tones. Placing one instrument of each kind at the transmitting and receiving station, then by connecting these forks at the transmitting station with a battery, an impulse or wave of electricity was made to pass from the battery over the intermediate wire to the receiving instrument at each vibration of each transmitting fork, the forks at the receiving station being operated by means of electro-magnets, controlled by the current passing over the intermediate wire. Each fork at the transmitting station having its mate at the receiving station, tuned to respond to the same number of vibrations per second as that at the transmitting station, the vibration of any fork of a given tone would send over the wire and the electro-magnets at the receiving station such number of electric impulses as would set in motion the particular fork attuned in sympathy with that tone or number of vibrations, and although the other magnets and their forks were in circuit, they would not be affected, for one the forks would only respond to the number of vibrations per second to which they were attuned.

A second transmitting fork being set in motion would start its counterpart at the receiving station; a third, also, and so on to the number of eight.

In the alternate starting and interrupting these tones, it was aimed to transmit the ordinary Morse signals, the operators at the receiving station to read them by the ear, as in the common Morse sounder.

Each of the gentlemen named succeeded to a certain extent in doing this, but all made it finally clear that in this direction comparatively trifling results of value were to be obtained.

Hence from this general notion each diverged into other paths, resulting finally, in the case of Edison and Bell—without following them through the labyrinth of experiments—in the speaking telegraph, or telephone, whereby the human voice is transmitted to a distant station and there reproduced in an audible manner.

Astonishing as it may seem, it is nevertheless the fact that these two experiments have obtained their results by widely different methods. Bell generates his electricity by vibrating an iron diaphragm placed close to the poles of a powerful permanent magnet, and receives the impulses thus simultaneously generated and transmitted upon a similar diaphragm placed close to the poles of an electro-magnet. This device is necessarily very restricted in its capacity.

First.—Because of the small quantity of the electricity possible to generate by the power of the human voice, thus limiting the power of the current to traverse a wire of any considerable length.

Second.—Because of the use of an electro-magnet for a receiver. It being well known that the element of time is an important matter in the charging and discharging of an electro-magnet, it will be readily understood that the great rapidity of these electric charges over-tax its capacity. Hence, high notes are frequently lost, or so reduced in volume as to be scarcely audible.

For these two reasons it will be seen that Mr. Bell's apparatus is limited to very short lines in its practical application.

Mr. Edison being a man of marked practical turn of mind, foresaw these limits, and in experimenting for solenoids for them having greater range of effectiveness, has created probably the greatest invention in electricity of the nineteenth century, namely, the electro-magnetic telephone. A brief description of it will show how entirely different in principle it is from that of Mr. Bell's, just described. The transmitting apparatus consists simply of a long tube, about two inches in diameter, having one end covered with a thin sheet brass diaphragm, which is kept tight by a screwing ring.

In the center of the brass diaphragm is riveted a thin disk of platinum, and immediately in front of this disk is an adjustable platinum-pointed screw, secured to a rigid pillar.

To transmit the music, it is only necessary to sing or play into the open end of this tube.

This causes the diaphragm to vibrate, and, the platinum points meeting, make the circuit, and the electric current transmits every vibration over the wire to the receiving end.

The receiving apparatus employed by Mr. Edison for reproducing the tones is based upon an original discovery made by him some five years ago. This discovery was that when a piece of paper, moistened with certain chemical solutions, is laid upon a metallic plate connected to the positive pole of a battery, and a platinum-faced wire connected to the negative pole of the battery, the wire is drawn over the paper, the passage of the current through it causes all friction to disappear, and the platinum-faced wire slides over the paper as iron upon ice; but if the current be interrupted, this effect instantly disappears, and the normal friction of the paper causes the wires to be drawn over it with difficulty. This principle is applied to the receiver—a resonant box, a drum or wheel, having flanges on both sides. This wheel is secured to a shaft rotated by the handles. A continuous strip of paper from the drum passes over the drum, the surface of which is roughened. Resting upon the drum is a smooth platinum point upon the end of the spring, which is secured to the center of the resonant box, and presses the platinum point with considerable force upon the chemically prepared paper.

The current from the battery passes to the spring, to the platinum point, thence through the moist paper—which in this state is a conductor—thence to the drum, and back to the battery.

The operation is as follows: When the handle is turned, the paper passes forward, and the normal friction between the point and the paper serves to give a forward motion to the spring; hence one side of the resonant box is drawn out. If, now, a wave of current passes through the paper, all friction ceases, and the spring not being pulled, the side of the resonant box regains its normal position; and this takes place at each vibration. By means of this friction the most feeble currents, which would not produce the slightest effect upon an electro-magnet, thus

exert extraordinary strength. This apparatus will respond and reproduce with great power the highest notes of the human voice, which are nearly inaudible when magnets are employed, the stores of their operation being due to the time required for the magnetization and demagnetization of the iron cores, and the production of secondary currents, which delay action and mutilate the signals.

This description refers more especially to the apparatus for the transmitting of the human voice in tone or singing.

The only difference between this and the speaking telegraph proper, however, is in the substitution of a phonautograph point for the platinum point in the adjustable screw of the transmitter. This, again, is another original discovery of Mr. Edison's, viz., that phonautography changes its electrical resistance with enormous rapidity under pressure, the effect in this application being that when the diaphragm is vibrated weakly, contact is made with the phonautograph point very lightly, and the resistance of the phonautograph being but slightly reduced, a weak current is sent out from the battery, and a weak effect produced at the receiving station. When, however, a strong pressure of the diaphragm is affected, by reason of the exercise of a more powerful vibration of the voice, the resistance is very greatly reduced, and a strong current passes to the line, and a strong or loud effect is produced at the receiving station. Hence the amount of power, with all its fine gradations, generated by the voice at the transmitting station, is transmitted in its proportions to the receiving instrument, and thus the fine articulation of the voice is obtained. This is of itself a wonderful invention, and will be of great value to electricians in other fields. The ability to send from a battery currents of different strength automatically, is a new and valuable invention in electricity.

[From the *Sunday Tropic, Trop., New York, Sept. 2, 1877.*]

THE EDISON TELEPHONE.

We had the pleasure of witnessing, by the courtesy of Mr. G. W. Crammer, the polite news agent of the Grand Union Hotel, the extraordinary performances of the Edison Telephone, in bringing vocal music from New York to Saratoga, upon a single wire of No. 8 gauge, in volume sufficient to fill the large hall of the Grand Union and United States Hotels, and in a manner enjoyable to a musical ear. The enthusiasm which pervaded the brilliant audience on this occasion, must extend to all votaries of science throughout the world.

The inventor, Mr. Thomas Alva Edison, of Menlo Park, New Jersey, is but 20 years of age, yet he has already contributed more to the telegraphic-art than any living man. He has taken out 139 patents and has filed sixty two additional ones. Among his inventions are the celebrated Quadruplex system, the American Automatic, the Homeseal Signal system, the Gold and Stick Reporting system, the Electrical Pen, and many minor inventions of practical utility. Among his original discoveries are his Electro Motograph, an instrument based upon the discovery that an electric current, passed through paper impregnated in a solution of chemical salts, lubricates it, thus destroying the frictional surface of the paper. This instrument forms the basis of his telephone, a natural force which he calls etheric force, and which has been discussed *pro* and *con* by American and European scientists, without conclusion as to whether it is really a new force or a new form of electrical action, a discovery that graphite has the property of reducing its electrical resistance under pressure, thus for the first time in the science, making it possible to send from one battery currents of graduated strength.

Many other phenomena have been noted by him, and will doubtless form the basis of valuable future inventions. Mr. Edison's telephone, it will be seen, is based upon entirely original principles. The transmitter, a tube into which the voice is thrown as upon its end a diaphragm; air waves thrown upon it by the voice make contact with the graphite battery points under various degrees of pressure, thus—as above shown—sending from the battery currents proportionate in strength to the vocal tones. This gives perfect articulation. The instrument for receiving or re-converting the electrical waves into sound waves is the electro motograph above described and is thus applied: An old style dialer is used to obtain a sounding board; a small metal drum is made to revolve, carrying upon its surface a strip of paper impregnated in chemical salts; a rigid metal arm is fastened to the sounding board and extending to the center of the drum, is made to bear upon the strip of paper with considerable pressure; when the drum is revolved, the paper is drawn under this arm and a strong friction is applied, which tends to draw the sounding board outward; the electric current is brought to the arm and made to pass through the paper, thus, at every impulse, destroying this friction and allowing the sounding board to regain its normal position; this vibration of the sounding board being controlled by the electrical waves, is, of course, in harmony with the voice of the singer, it will be seen that this telephone differs to tally from Prof. Bell's and Mr. Gray's.

Prof. E. H. Johnson, who gave a scientific explanation of the above described wonderful invention, fully understands his subject, and is one of the most expert telegraphists in the country.

[From the *Chronicle (Pa.), Evening News, Sept. 28, 1877.*]

A fine audience assembled in Holly Tree Hall last evening to hear a telephone concert, the performers of which were at the Western Union Telegraph Building, Trenton and Chestnut streets, Philadelphia.

The sounds were transmitted over one of the regular wires of the above company to the P. W. & B. depot, and thence by a copper insulated wire to an Edison singing telephone on the stage of Holly Tree Hall.

Mr. Edward H. Johnson, electrician, was in charge of the instrument, and he opened the entertainment by a brief lecture upon its merits. * * * Mr. Edison's speaking telephone was also described, and it is likewise said to be founded upon a newly discovered property of graphite, viz: that when subjected to pressure it rapidly increases its conductivity; thus by making it a portion of the circuit through which the talking is done, a graduated series of electric current is had from the battery, and articulated speech obtained in a very practical manner. This invention was described at some length, but not exhibited. He explained that the speaking telephones were not going, as many supposed, to revolutionize the present system of telegraphy; on the contrary for the ordinary commercial business of the country they were of no practical utility, as no man wants to have verbal messages on matters of business, and the necessity thus imposed for writing them down reduces the capacity of the wire after all to the capacity of the penman. But for private use, between offices, factories, residences, fire and police and mines, the telephone is the absolute perfection of a regular telegraph, as it requires only that the operator shall be able to talk—a feat we all accomplish while still young.

[From the *Daily Graphic*, Wednesday, April 17, 1878.]

TESTING THE TELEPHONE.

SEVERAL SUCCESSFUL EXPERIMENTS WITH EDISON'S INVENTION IN ENGLAND.

PHILADELPHIA BRANCH OFFICE OF THE "GRAPHIC," April 16.—The "Wizard of Menlo Park," as the "Graphic" has appropriately termed Thomas A. Edison, the inventor, has received a cable dispatch from his agent in England stating that his telephone has withstood several severe tests there, and has been found successful over all competitors. Mr. Adams, who was employed in his laboratory at Menlo Park, sailed for England about four or five weeks ago, carrying with him a complete set of Edison's Telephones, comprising the latest improvements for transmitting and receiving vocal sounds, some of the apparatus having been invented within two or three days previous to his leaving. Several of the Telephones invented by other persons had been tried previously in England, but failed, owing to their inability to overcome the "induction," or electrical force of the other wires, which rendered the speaker's words inaudible to the receiver. Edison's however, both in England and this country, effectually conquered all electrical disturbances, even upon the duplex and quadruplex wires, with their batteries ranging from two hundred and fifty to three hundred cells each, which formed the most severe test ever given any Telephone. His instrument differs from the others in the fact that Bell's, Gray's and Preece's are all worked with permanent magnets, which have only a limited capacity, as there is no battery attached, and are more effective in small local circuits than in long distances where there are numerous wires interfering. Edison's is upon the electro-carbon plan, and worked with a small battery which is capable of being intensified in an almost indefinite degree, together with a small Ruhmkorff coil. Under the most severe tests his telephone has been found to operate perfectly, and has been distinctly heard at a distance of 250 miles. Mr. Adams stated that notwithstanding the fact that the English telegraph wires are under ground and are therefore much more difficult to operate the Telephone upon, Edison's invention stood the test successfully, and was pronounced perfect. It is probable that a company will be formed in London which will have the sole right to use his invention in Great Britain.

On Thursday next another severe test will be given the instrument by Professor Joseph Henry, of the Smithsonian Institution, who will operate it between this city and Washington. There is no doubt that it will be as successful in this trial as in the previous experiments, and still further prove the superiority of the electro-carbon to the magneto system.

"ALBERTO."

GENIUS BEFORE SCIENCE

The Academy's sessions resumed their regular session yesterday at twelve o'clock noon. Prof. Marsh in the chair. Prof. Newcomb, the well known Washington astronomer, read his paper on "A Plan for Measuring the Velocity of the Earth's Motion by the Spectroscopic Method," and layfold gave, adorned by a pair of dark side whiskers, and seemingly too youthful for the position, the highest living authority on astronomy. His essay was marked by the scientific precision and force and boldness characteristic of him, the fundamental idea being the motion of light from a considerable distance, say one or two miles, by means of the spectroscopic method. The paper was a very ordinary paper in itself, but the Remarks on this paper were made by Prof. Barker, E. F. Barker, Prof. F. E. Barker, and Alexander. Prof. William A. Norton, of New Haven, Conn., then followed with a paper on "The Effective Force of Molecular Action." Prof. Norton is a very young man, a recent graduate, showing there is a singular science as well as musical and artistic Christianity. His paper was a very ordinary paper in itself, but the Remarks on this paper were made by Prof. Barker, E. F. Barker, Prof. F. E. Barker, and Alexander. Prof. William A. Norton, of New Haven, Conn., then followed with a paper on "The Effective Force of Molecular Action." Prof. Norton is a very young man, a recent graduate, showing there is a singular science as well as musical and artistic Christianity. His paper was a very ordinary paper in itself, but the Remarks on this paper were made by Prof. Barker, E. F. Barker, Prof. F. E. Barker, and Alexander. Prof. William A. Norton, of New Haven, Conn., then followed with a paper on "The Effective Force of Molecular Action." Prof. Norton is a very young man, a recent graduate, showing there is a singular science as well as musical and artistic Christianity. His paper was a very ordinary paper in itself, but the Remarks on this paper were made by Prof. Barker, E. F. Barker, Prof. F. E. Barker, and Alexander.

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he could talk to eight persons in a group at one time, and forthwith began to do so, the sylvan passing by in order and each one in turn having a chat with the Philadelphian. Having talked him out, Prof. Barker announced that telephonic communications would be established with the Western Union Telegraph Office, corner of Fourteenth street and Pennsylvania avenue, in Washington, where the curious could continue their conversation at a distance, while the professors went back to their reticence and hatching.

II.

[From the *Telegraphic Journal*, January 1, 1878.—*Vol. VI., No. 118.*]

The Articulating Telephone of Mr. THOMAS ALVA EDISON, the distinguished American electrician, followed hard on the back of Professor Bell's, and is said to yield louder sounds, although the articulation is not so perfect, and the apparatus is much more complicated. Its action is based on the discovery of Mr. Edison's, that plumbago has the property of diminishing in resistance under pressure in a degree proportionate to the pressure. This newly-discovered property of plumbago promises to become a useful one in telegraphy. Mr. Edison has constructed a novel relay on the principle.

I.

[From *New York Daily Tribune*, Saturday, April 20, 1878.]

TELEPHONE AND PHONOGRAPH.

The Academy formally adjourned during the presentation of the Telephone and Phonograph, but resumed proceedings as soon as the exhibition was finished, and the members, meanwhile, kept their seats, except so far as they resigned them to the ladies. The instruments were brought in. They included a varied and large collection of telephones of different construction—their numbers enabling several persons to place them at their ears simultaneously.

Professor G. F. BARKER, of Philadelphia, opened the performance with a brief address, in which he said he wished to give credit to whom it is due for the Articulating Telephone. Its conception is very old. Its first distinct description appears in a caveat filed by Elisha Gray, but it does not appear that it had then been actually used to transmit speech. This use was first accomplished by Professor Graham Bell more a fortnight, Dr. Barker said, to foreigners than anything else, except, that time, which prevented the latter from sleeping for three weeks. Dr. Barker once lost morning in the Centennial Summer. A full account of this was given afterward in the *Tribune*. The Emperor, Don Pedro and Sir William Thomson

took part in these experiments, and the voices of each of the party were recognized by their peculiarities of speech and accent. Since then the instrument has been developed in several new forms. Professor Dubucq is said to have first substituted the permanent magnet for the electro-magnet in the telephone. The form and construction of different instruments were described and illustrated by diagrams, and by means of the telephones themselves. The Bell telephone is the loudest of the magnet contrivances, but its sounds are confused with other sounds on wires in general use. The Phelps duplex telephone utilizes both poles of the magnet and gets rid of the resonance chamber, so that its sounds are purer. The Gray, bi-polar telephone divides the sound received by it between the two poles of the magnet.

The Edison carbon telephone is a complete novelty. Mr. Edison had discovered that certain kinds of carbon are enormously susceptible to changes in conductivity upon being subjected to different pressures. He conceived the idea of utilizing this property to transmit sound by the pressure of the sound waves, arranging so that the differences of pressure should cause corresponding changes in the electrical status of a telegraph wire. A button of sensitive carbon is placed between two pieces of platinum; the under piece of metal is attached to the telegraph wire; the upper piece is very thin, and is to receive the pressure of the sound waves that is communicated through some intermediate substance from the centre of a receiving disk, such as is inseparable from all forms of telephones. Talking to the disk causes it to vibrate, and thus to produce differences of pressure on the carbon button. Finally, a two-cell battery is put into operation, with one of its wires attached to the upper and the other to the lower piece of platinum, the circuit being closed by transmission through the carbon button between the platinum plates. The transmission is less or more impeded, according to the pressure which the sound waves exert upon the carbon button, and the telegraphic wire communicates these changes of electrical status to a distance, for repetition in a receiving instrument. The use of a battery instead of a magnet gives a certain sharpness to the sounds sent by this instrument, so that they overcome other sounds and give it a distinct utterance. Dr. Barker said that the whole credit of this most ingenious invention should be given to Mr. Edison. The phonograph was then described, and Dr. Barker, after dealing with a glowing tribute to the inventive talents of Mr. Edison, formally introduced him to the Academy. The Vice President, Professor Marsh, joined in the welcome in brief, well-chosen words.

Mr. Edison appeared somewhat overwhelmed by the attentions, and asked Dr. Barker to express his thanks. This was neatly done, including a suggestion that Mr. Edison's work would now speak for itself. The phonograph was thereupon exhibited, and performed excellently, to the intense amusement of the audience, who, returning words, songs, laughter, whistling, growling and other sounds, with great clearness. Telephonic communication was then made with Philadelphia; and all elements of the audience that desired had an opportunity for trying the various telephones.

[From the *Daily Graphic*, Tuesday, April 30, 1878.]

EDISON'S CARRON TELEPHONE.

In what respect, Doctor, is it superior?

Other telephones are very likely by induction to scatter their news where it is not wanted and where it has not been sent, and to pick up from telegraph wires all manner of messages, sounds and tele. very confusing to the ear—so confusing, in most cases as to make communication by the telephone in the vicinity of other wires impossible. Edison's is the only telephone yet made which is comparatively free from this sympathetic characteristic. It mingles its own business, carries the message where it is sent, and is very free from the evil effects of contact. No other telephone can be operated on the same pole that contains a large number of telegraphic wires. In any case the wire for telephonic purposes will have to be distinct from that which carries ordinary telegraphic messages, but Edison's telephone will articulate plainly and convey a message carefully on a wire which is in a bundle of telegraph wires.

You anticipate then, Doctor, that the Gold and Stock Company will find its business greatly increased by the invention and employment of the telephone?

There is not a doubt of it. Every city will introduce the telephone system as a means of communication between a gentleman's house and his office, between one office and another, or between an office and a factory, or to cover any short distances. It has already been largely introduced, and the demand for it is rapidly increasing.

wire surrounding one or both poles were therefore substituted by him in place of the electro-magnets and battery previously employed.

Another important improvement which was made consisted in using the same in-

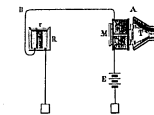


FIG. 6. EDISON'S SPEAKING TELEPHONE.

strument for both sending and receiving instead of employing instruments of different construction, as had been previously done.

The principle and mode of operation of the improved apparatus is represented in figure 7.

It consists of an ordinary permanent bar magnet, N S; a single helix, H, of insulated copper wire placed upon one end of the magnet, and a metallic diaphragm, D, consisting of a disk of thin sheet-iron two and a quarter inches in diameter and one fiftieth of an inch thick, forming an armature to the magnet, N S. The vibratory motions of the air produced by the voice or other cause are directed toward, and concentrated upon, the diaphragm, D, by means of a mouthpiece, T. It will thus be seen that when vibrations are communicated to the air in front of the mouthpiece the impact of the waves of air against the elastic diaphragm will cause a corresponding movement of the latter. This in turn, by exciting the magnet, disturbs the normal magnetic condition of the helix, and since any change of magnetism in this tends to generate electrical currents in the surrounding helix, the circuit in which the helix

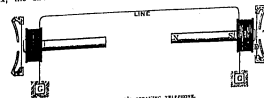


FIG. 7. GRAHAM'S SPEAKING TELEPHONE.

may be placed will be traversed by a series of electrical pulsations or currents. Moreover, as these currents continue to be generated so long as the motion of the diaphragm continues, and as they increase and decrease in strength with the amplitude of its vibrations, thus varying with the variations of its amplitude, it is evident that they virtually possess all the physical characteristics of the agent acting upon the transmitting diaphragm. Consequently, by their electro-magnetic action upon the magnet of an apparatus, identical with the one above described and placed in the same circuit, they will cause its diaphragm to vibrate in exactly the same manner as that of the transmitting apparatus.

Mr. Thomas A. Edison, of Menlo Park, New Jersey, has invented a telephone, which, like that of Gm, shown in figure 6, is based upon the principle of varying the strength of a battery current in union with the rise and fall of the vocal utterance. The problem of practically varying the resistance controlled by the diaphragm, so as to accomplish this result, was by no means an easy one. By constant experimenting, Mr. Edison at length made the discovery that, when properly prepared, carbon possessed the remarkable property of changing its resistance with pressure, and that the ratios of these changes, moreover, corresponded exactly with the pressure. Here then was the solution, for, by vibrating a diaphragm with varying degrees of pressure against a disk of carbon, which is made to form a portion of an electric circuit, the resistance of the disk would vary in precise accordance with the degree of pressure, and consequently a proportionate variation would be occasioned in the strength of the current. The latter would thus possess all the acoustical properties of the vocal waves, and by its reaction through the medium of an electro-magnet, might then transfer them to a metallic diaphragm, causing the latter to vibrate, and thus reproduce audible speech.

Figure 8 shows the telephone as now

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THE TELEPHONE AND THE PHONOGRAPH.

constructed by Mr. Edison. The carbon disk is represented by the black portion, E, near the diaphragm, A A, placed between

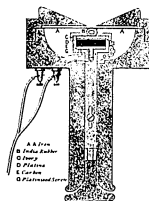


FIG. 8. EDISON'S TRANSMITTING TELEPHONE. TRANSMITTER DETAIL.

two platinum plates, D and G, which are connected in the battery circuit, as shown by the lines. A small piece of rubber tubing, B, is attached to the center of the metallic diaphragm, and presses lightly against an ivory piece, C, which is placed directly over one of the platinum plates. Whenever, therefore, any motion is given to the diaphragm it is immediately followed by a corresponding pressure upon the carbon and by a change of resistance in the latter, as described above. It is obvious that any electro-magnet, properly fitted with an iron diaphragm, will answer for a receiving instrument in connection with this apparatus.

Figure 9 shows a sending and receiving telephone and a box containing the battery. Many other modifications of the speaking telephone have been devised, but they all possess certain common characteristics embodied in Mr. Gray's original discovery, and are essentially the same in principle, although differing somewhat in matters of detail. All, for example, employ a diaphragm at the transmitting end capable of responding to the acoustic vibrations of the air; all employ a diaphragm at the receiving end, capable of being thrown into vibration by the action of the magnetizing battery corresponding to the vibrations of the transmitting diaphragm; and finally, all depend

for their action upon modulating electric currents produced by the vibratory motion of a transmitting diaphragm which increases and decreases the number and amplitude of the electric impulses transmitted over the wire without breaking the circuit.

During the past year many ingenious persons have turned their attention to the subject of speaking telephones, and by the introduction of various modifications have succeeded in greatly improving the invention, so as to make it available for practical use. Prominent among these is Mr. G. M. Phelps, an inventor of several valuable telegraph instruments, to whose ability in the scientific arrangement of details in the construction of the apparatus, the public is indebted for the most effective telephones yet introduced. The peculiar excellence of these instruments consists in their distinct articulation, combined with a loudness of utterance that is not met with in the numerous other forms that have appeared up to the present time. Both of these qualities, manifestly so desirable, are, in these in-

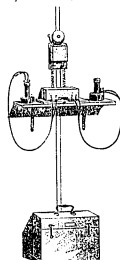


FIG. 9. EDISON'S SPEAKING TELEPHONE. TRANSMITTER AND RECEIVER.

struments, developed to a very remarkable degree, while the distance over which they may be used is also another of their distinguishing characteristics, circuits of over one

[From the *Philadelphia Enquirer*, Tuesday, April 16, 1878.]

THE TELEPHONE.

LECTURE BY PROFESSOR GEORGE F. BARKER, OF THE UNIVERSITY.—THE SCIENCE OF SOUND AND ELECTRICITY—THEIR APPLICATION TO THE TELEPHONE AND PHONOGRAPH—(WITH ILLUSTRATIONS.)

The Academy of Music was crowded to its utmost capacity last night with an audience which was delighted by one of the most valuable lectures given during many years in that building.

The lecturer was Professor George F. Barker, of the University of Pennsylvania, and his subject was that of the telephone and phonography, a theme than which few others have a more intense popular interest at this time. The lecture extended over a period of nearly two hours and a half, during which time the audience followed the lecturer with close attention, while he made perfectly comprehensible every phase of the wonderful invention of which he treated.

Professor Barker began by explaining the science of sound, enabling the audience to not only hear musical intervals, but to see them by means of reflections of the sound waves thrown on a screen. It was shown that the pitch is higher as the wave is shorter, and that solids readily transmit sound. The waves were reproduced on the screen as reflected from a mirror, which caught them as they were made by the lecturer speaking against a diaphragm made of distended rubber or blowing an organ pipe against the film of a soap bubble.

These curious experiments gave the utmost pleasure to the audience, which gave in turn ample evidence of that fact. A photographic exhibition was given by Professor Batchelor, who spoke in the receiver the words of the familiar verse, "Mary had a little lamb," &c., and after a few short sentences, such as "hallo," the verse:

There was a little girl,
And she had a little curl
Right in the middle of her forehead.
And when she was good, she was very, very good,
But when she was bad she was horrid.

A large paper cone was then adjusted in the apparatus, with the large end of the cone toward the audience, and as the Professor turned the crank, his words were repeated clearly and distinctly as he had uttered them, perfect as to pitch and manner of delivery, but in a sort of nasal, suppressed tone that would have suggested ventriloquism were the integrity of the performance not absolutely above even the slightest suspicion.

The audience applauded the phonograph recitation so warmly that, before the matrix was removed a second recitation was given, after which, to show the cues with which various sounds can be repeated by it, Professor Batchelor gave successively reproductions from it of a hearty laugh, the clucking of a hen, the crow of a rooster, &c.

The next entertainment in the Star Course will be on Thursday evening, when there will be a grand double concert given.

WHAT IS SAID OF IT:

[illegible][illegible]

FROM NEW YORK TO ALBANY!
Admission 50 and 85 Cents.

from window spaces and window frames. Scrubbing brushes, vigorously applied, might remove them. Any simple device would serve to divert the dirty drippings into a receptacle, and the same device would serve to divert the water from the window panes into a black trough. As it is, the model Philadelphia brick house, with its white interstentions and black streaks, is a reproach and shame to the city of Philadelphia. The writer has seen the model brick house, many times, and has seen the same thing in all other houses, many reasonably expect to reap public gratitude, and, perhaps, something more satisfying. Entire blocks of houses have so changed countenances have "so gone down," when a single street in all other respects unchanged. The subject under consideration has for a long time interested the writer from a utilitarian standpoint, rather than a scientific one.

EDISON'S CARBON TELEPHONE TRANSMITTER, AND THE SPEAKING PHONOGRAPH.

By S. M. TOWN.

Both the telephone and speaking phonograph are instruments of American invention, and have undoubtedly excited more wonder and admiration throughout the world than any other modern contrivances when this date away their practical uses will begin.

The telephone has already found its way into the household, beyond the limit of its capacity. Quite recent improvements, however, have greatly increased its power, thus rendering it more efficient for all practical purposes, like all others are not the result of one mind, nor the products of a day; on the contrary, they are the results of many men's diligent experiments, and the wisdom of many of them. Prof. Doherty, of Germany, constructed the first telephone in 1861. In his

instrument the electric current was broken by delicate springs, resting on a tightly-stretched membrane or diaphragm, which was thrown into vibration corresponding exactly with the vibrations of the sound waves. The receiver of the instrument was constructed on the principle first demonstrated by Prof. Henry, that iron expands when under the magnetic influence of electricity, and contracts when the influence is removed. The receiver, in this case, consisted of a bell-shaped iron box, or vessel, supported on a sounding box, and vibrated by these lengthenings and shortenings, made distinctly audible, at the receiving end, the vibrations of the transmitter of sound, the phonk. Further experiment was necessary to render the instrument more efficient.

The apparatus was capable of reproducing but one of the characteristics of sound, the pitch. Further experiment was necessary to render the instrument more efficient. Prof. Gray, of Chicago, in 1874, gave to the world his harmonic telephone, based on the same general principles as that of Edison. It was capable of reproducing all the elements of sound, and of transmitting sounds of different pitch, and reproducing the same at almost any distance.

It is worthy to note that Prof. Bell, of Boston, consisting of a tightly stretched membrane, having a small permanent magnet fastened to its centre, in front of, and close to, the membrane. The vibrations of this membrane and permanent magnet, would necessarily induce a magneto-electric current in the coils of the electro-magnet, and this current would be transmitted to the receiving end, where it would induce a similar vibration and produce sound. The receiving instrument consisted of a tubular electro-magnet of a single coil, and a small permanent magnet, which was the magnetizing action of the bell. Its capacity was extremely limited, the sounds were weak, and could be used only for work in demonstrating the possibility of transmitting and reproducing articulate sounds.

Prof. Doherty, of Boston, the same year, failing to see the importance of changes in the intensity of sound, and the fact that it is not only the pitch, but the intensity, which is necessary for the transmission of sound, substituted permanent magnets, with small electro-magnets around the poles, for the electro-magnets and galvanic

lattery of Bell.] Another reliable improvement consisted in using the same instrument for sending and receiving, in lieu of instruments of different construction, as had been done previously.

As will be seen, when the vibrating motions of the air are concentrated in a single direction, the vibrations of the diaphragm, which it produces, will likewise be concentrated in a single direction. If a magnetized bar and induces electric currents in the surrounding coils, corresponding in all respects to the vibrations of the cone, placed in the same circuit, they will cause the diaphragm to vibrate in precisely the same manner as that of the transmitter. The principle of the Edison telephone is based upon the fact that the diaphragm, in the transmission of articulate sounds, is that the electric current is never entirely broken, as is the case in the telephones previously in use.

While all sounds may be faithfully transmitted and reproduced by this instrument, its capacity is not great, and when used on lines of considerable length, the transmission of the sound is so feeble that the hindering influence of induction is so great as to render those sounds inaudible.

Notwithstanding this difficulty, Thomas A. Edison, of Menlo Park, N. J., succeeded in constructing a series of experiments, and at length discovered that carbon, properly prepared, possessed the property of changing its conducting capacity with the pressure applied to it, and in some cases, when the pressure was applied in a particular direction. By varying degrees of pressure against a disc of carbon forming a part of an electric circuit, the resistance of the disc would vary in proportion to the pressure applied, and the current passing through it, therefore, be occasioned in the strength of the current, which would thus possess all the characteristics of the vocal vibrations. By connecting this instrument with a telephone receiver, the sound transmitted in its present state of development, conversation has been maintained between Philadelphia and Washington, a distance of nearly 200 miles. The apparatus used in this experiment is shown in Fig. 1, and is of the following nature:

The improvement in the telephone here outlined is from Edison, it was obtained by Ford, Bell, and is embodied in the instrument described on p. 270, et seq. See, also, the accompanying drawings.

Many modifications of the speaking telephone have been devised, but they all embrace one or other of the principles heretofore described. That of G. M. Phelps, New York, called the duplex telephone, characterized by its peculiar excellence of articulation, is perhaps the most perfect of the kind.

Fig. 1 represents the carbon transmitter of Edison, above referred to.

a, the carbon disc; *b*, the platinum plate, connected in the local circuit. Resting on the platinum, *f*, is a small disc of glass, *h*, of the same diameter as the carbon. On its upper surface is a small hole, *c*, of the same diameter as the carbon disc. This plate does not vibrate as the diaphragm in the ordinary telephone, being quite rigid; it simply arrests the atmospheric condensations, and conveys them, by direct contact, to the carbon.

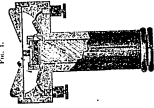
g, the mouthpiece. *d*, *e*, wires extending through the handle from the platinum, *a*, to the unit, *h*, and from the carbon, *b*, to the same unit, so arranged as to be capable of any desired longitudinal adjustment.

Edison's speaking telephone, which is an entirely new and original invention, is an improvement upon the ordinary telephone, in that it is capable of transmitting sounds of a much greater intensity than the latter. It would be impossible to fully represent the nature of the sound which it conveys, but it is a wonderful instrument, and one which is of great value in the transmission of sounds.

It can be seen that the sound is not only conveyed, but it is also amplified. It is a fact that the sound is amplified, and it is a fact that the sound is amplified. It is a fact that the sound is amplified, and it is a fact that the sound is amplified.

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INFORMATION OF INTEREST

THE DEVOTEES AND VOTARIES OF SCIENCE

THE TEACHER AND THE STUDENT;
THE PRACTICAL MAN OF BUSINESS;
THE CULTURED MAN OF EASE;
THE MUSICIAN AND HIS VOIARINS;
THE LOVERS OF THE CURIOUS AND NOVEL;
THE AMERICAN GENIUS—AMATEUR OR VETERAN;
THE YOUTH OF THE LAND WHO WILL LIVE TO
SEE THE GERM EXPAND AND MATURE.
AND ALL INTELLIGENT MEN, WOMEN AND
CHILDREN.

New York:
RUSSELL BROTHERS, PRINTERS.
17, 19, 21 23 HOOK STREET.
1877.

[illegible]

THE TELEPHONE:

ITS ORIGIN AND DEVELOPMENT

A BRUFF SKETCH BY EDWARD, III. JOHNSON

Chas. G. F. an American physicist, discovered in 1872 that the rapid magnification and demagnetization of an iron bar produced musical sounds, the vibrations of the iron being caused by its change of form under the action of the electric current.

Philipp Reis of Frankfurt, Germany, reproduced the musical sounds at a distance for the first time by means of electricity, this being undoubtedly the original telephone, and in form closely approximating the present perfect instruments; in fact, supplying to most modern inventors the main principle of their construction, the magnetic induction coil and diaphragm.

His invention is thus described: A wooden box having an operant, with fluted shaped tube and mouth piece inserted; and another over which is stretched a membrane, diaphragm, having affixed to it a coil of fine wire, and a battery of cells, the electric current being operated upon a telephone bell, the central contact being the instrument for taking up and repeating the vocal vibrations into an electric circuit.

A certain note is sounded in the box, the diaphragm will take up the motion of the air waves, and by closing the circuit will repeat the sound, and by closing the lever contact points at several wares, which travel over the air waves, as repeated waves, which travel over the air waves, as repeated waves by the

[illegible]

tricity and the consequent volume of sound is necessarily very trifling, and has a limit fixed by the vocal power, beyond which legitimacy is of no avail to amplify it. In order to make these weak currents effective to vibrate the diaphragm of the receiver, the diaphragm must be quite thin and the coil of high resistance; this requisite entails the one serious defect in Prof. Bell's instrument, viz., great susceptibility of the receiver to the inductive action of the currents flowing upon adjacent telegraph wires. The active principle of his invention being less intensely from an electric conductor by *absolutely insulating* from the inductive field, radiating with more or less intensity. Inductive currents cannot be confined to a conductor like battery currents by insulation; thus, two Bell telephone wires, placed side by side, will receive one from the other, and deliver to my ear the message intended solely for yours, or *vice versa*; or in the case of the proximity of such telephone wire to a number of wires, telegraphic and telephonic, a label of the latter voices is heard, out of the depths of which the latter must gather the sounds meant for him, which, in many cases, by reason of the powerful inductive action of most telegraph wires, are weaker than the sounds due to such foreign currents.

This characteristic has been noted and commented on by individuals and the public press in all parts of the country where the instruments have been tried, and more especially in New York and the New England States, upon the occasion of the public exhibition of Edison's singing telephone, when the music was conveyed from New York city to Saratoga, a distance of 200 miles, and was heard upon Bell telephones in various cities and towns not only on the route of the Edison telephone circuit but from 100 to 150 miles in an opposite direction. Thus, the owners of these telephones in

Albany, Troy, and various minor towns in New York State, and Hartford, Conn., and Portland, Me., and Providence, R. I., and enjoyed music intended only for an audience in Saratoga. To those who overlook the fact and therefore become a receptacle for all inductive currents that may approach it, this seems marvelous in effect produced upon an instrument in Rhode Island but they fail to consider the fact that this wire runs distance through and out of New York city, and that the inductive action of the battery currents of the Edison telephone, together with the rapid vibration of the current to produce musical sounds enhancing their inductive action, would pass currents to the Rhode Island wires, and thence to the telephone wires, stronger than those of the true telephone currents, hence amply sufficient to operate that marvellously delicate instrument. The how, if so noticeable in America, it must be magnified in England, where larger numbers of wires are placed upon one set of poles, and where underground telegraphs to demand, nullifies the value of the invention.

As any increased delicacy of the receiving instrument entails this defect in a more marked form, it would seem clear that Prof. Bell is limited in increased sound production at both ends. In short, this extraordinarily sensitive invention, like a sensitive woman, is fitted to adorn the parlour than to cope with the rougher elements of a practical sphere, and while it may and certainly will prove practical upon short isolated wires in quiet nooks, for lines of any considerable length or

the busy marts of trade—the latter the great field for the telephone—we are compelled to still look ahead for a thoroughly practical instrument.

I will now consider Mr. Edison's production, to see if it has obtained that which he early saw would be the only practical telephone, viz., one that was operated by battery currents, which currents have alone proven effective in all other branches of the telegraphic art.

Mr. Edison, in 1875, had well under way his present speaking telephone, but did not pursue it with assiduity until a later period, when he began to give the subject his undivided attention; his aim was to find a means of raising the degree of strength of a battery current in exact union with the rise and fall of the vocal utterance; to do this he knew he would be compelled to produce the same number of electric waves per second as there were air waves in the vocal flow, the same amplitude or length of waves to obtain the intensity, and the same form to obtain the quality.

To produce this manipulation of a battery current was truly a Herculean task, and after exhausting every possible device which a wonderful fertile brain could devise, Mr. Edison became satisfied that to effect the result he must enter the field of original investigation. Nothing daunted, however, he did so, and for the second time in the brief space of five years, compelled reluctant nature to yield to deliberate assault, and provide from her wonderful storehouse a principle new to the scientific world.

The discovery thus made really advances the state of the telephone art, because it furnishes a new basis for invention. It is this: When certain forms of carbon are subjected to pressure their conductivity is increased, and in the direct ratio of that pressure. Hence, then, was the great desideratum, for by a vibration of the diaphragm, with a varying degree of pressure against a

stick or disc of carbon, which should constitute a portion of an electric circuit, the electrical resistance of that circuit would vary precisely in union with that degree of pressure, and a proportioned variation of the strength of the battery current be obtained, thus giving the full characteristics of the vocal air wave to the electric wave. An electro-magnet with diaphragm attachment placed in waves into sound waves and thus reproduce the vocal utterance. This general principle having been proven by experiment to be correct and effective to a certain degree, and to offer the only perfectly practicable solution of the telephonic problem, to amplify and intensify many thousands of experiments, Mr. Edison sought, by the effort, in order to obtain a degree of battery variation that would enable him to operate comparatively long lines and a receiver too crude to be affected by inductive currents, and has finally succeeded in doing so, beside of unlimited opportunities for future expansion and growth. The diaphragm of his receiving instrument being one sixteenth of an inch thick and the resistance of the electro-magnet low, the instrument fails to respond to inductive currents while producing articulate speech with very considerable power.

Such is the present state of the speaking telephone. Much misapprehension exists as to the effect their introduction will have upon present systems of telegraphy. Many anticipate a revolution in the art, etc. True, there will be a revolution, but it will be for a long time confined to private lines—that is to say, to those owned or controlled by individuals or an association of individuals, operated solely by them for their private business; for this purpose the telephone is the *par excellence*, as it requires neither "operator" or the acquisition of skill or study of symbolic characters. It is the

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embodiment of simplicity in its mechanical construction, while performing the most complex and diversified electrical work. It cannot, however, enter into the problem of cheapening telegraphy in a commercial sense, inasmuch as the public must delegate to corporate bodies the carrying of their telegrams, and neither telegraph company or the public will receive one from the other *retail* messages; they must be written, and this necessity neutralizes any advantages that might otherwise accrue to the telegraph company by reason of the increased capacity given a wire by the application of the telephone. Hence, methods already in use point of the transmission of a greater number of messages in a given time than could be done by the telephone, were it ever so perfect. The sphere of the speaking telephone, then, in the present economy of the telegraphic system, is that of private or individual use, but it will not be confined there, as it is a radical innovation on old systems, so will it work *valuably* new fields; to predict the precise direction in which they will be found is not my object or province, that I delegate to my readers as a pleasurable work for their fancy. I can only promise them that, let their fancy roam ever so wildly, they will in all probability live to see its full fruition, *realize* this bold prophecy.

In the elaboration of experimental research in any given direction, and for a specific purpose, Mr. Edison, who is a close observer, has not infrequently made incidentally discoveries of greater importance than the perfecting of the specific work in hand, and his telephonic investigation is *no exception*. In making this statement I am conscious of the fact that I am *overstepping* the talking telegraph to the limits of the *unfulfilled*—completed, and no longer a wonder—but such is frequently the fate of important discoveries; they bring in their train others equally as valuable and important, and more wonderful.

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indentations, except that it has a very delicate diaphragm.

A hair spring with a V shaped point is placed in such position that the V rests on the indentations and is held there by the spring. Fastened to this spring is a thread, which extends upwards in the inverted diaphragm and is fastened therein.

Now, when the paper is drawn along, the point slides up and down over the indentations, carrying the diaphragm with it, the result being a vibration of the diaphragm in exact duplicate of the motion of the original diaphragm, and of course a more or less accurate redelivery of the words.

Now, if this second diaphragm be that of the telephone speaker, the words would not only be redelivered, but transmitted by electricity to a distant point as well. This simple device of course fails to reproduce with exact fidelity the fine articulations, but it serves to illustrate the principle, and to indicate the possibilities of such invention. Mr. Edison has in mind many hundreds of methods whereby he will seek to make this invention perfect, and inasmuch as he purposes taking it in hand at an *early* day, recorded speech, with power of self redelivery, may be considered as among the near realities if not already so. Mr. Edison himself believes he can perfect such a machine and put it before the world for practical use within a year.

He has already applied the principle of his speaking telephone, using an electro-magnet to set the diaphragm in vibration, and thus make the indentations; by which method he will be able to transmit a speech from Washington to New York, and automatically record it for immediate or future redelivery. A speech delivered on the floor of the Senate could be transmitted to New York, there automatically recorded, and, by the application of telephones, redelivered in the respective editorial cans of the New York dailies.

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For want of a better name, I will call the invention

EDISON'S TRANSLATING PHOTOGRAPH.

The idea being to record speech, and at any time—five, ten or fifty years subsequently—so redeliver it with all the vocal characteristics of the original speaker. Experiments sufficient to satisfy the inventor of almost complete success have already been made. The apparatus, though crude, is wonderfully simple in character. To a speaking tube, with mouth piece and diaphragm somewhat similar to the telephone speaker, but with greater vibrating power, in the centre of the diaphragm, is attached a small chisel shaped point. A clock work revolves a drum, carrying forward a continuous strip of paper, having lengthwise a sharp V shaped raised boss in its centre, which has been previously prepared by passing it through an embossing machine, like a Morse register.

The chisel point upon the diaphragm is made to rest upon the boss of this fillet of paper as it is drawn forward by the drum—the paper having nothing underneath to support it, but simply being held fast; indentations in the boss are very easily made, and have a scarcely appreciable effect upon the vibrations of the diaphragm. If, now, the paper be drawn forward at a proper rate of speed, all the movements of the diaphragm are reduced by indentations in the raised boss—the strong and loud times by deep, and the lower tones by shallower indentations. It will readily be seen that the paper will receive the number of vibrations per second as well as their amplitude. Thus the spoken words are accurately recorded on the paper, and to have them spoken it is only necessary to so apply a second diaphragm as to be controlled in its movements by the indentations on the paper. This instrument may be similar to the one used in making the in-

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Incidentally, likewise, with the progress of these investigations, Mr. Edison has invented a telephone for the transmission of musical sounds over long distances, and reproducing them with great accuracy, and in such volume as to be clearly and distinctly heard by the whole audience in the largest halls obtainable. This invention, by reason of its great range of sound production, and the distance from which it will convey music, as well as the fact that it reproduces the music of the human voice enjoyably, has attracted a degree of popularity truly surprising. No invention of modern times has attracted such an array of the curious of all classes. As an instrumentality in conveying general information, and giving the whole people an insight into the mysteries of electricity, this invention has—as in the capacity for reproducing a volume of sound—no competitor the world over. It is known as

EDISON'S ELECTRO-MOTOGRAPHIC MUSICAL TELEPHONE.

As in the speaking telephone, a tube, a mouth-piece and a diaphragm are used, but in this its direct interpretation of the current is made by causing the diaphragm to vibrate against a platinum point fixed immediately in front of it upon an adjustable screw—a corresponding point being fixed to the centre of the diaphragm. This is the principle of the instrument, although, to prevent rebounding of the diaphragm and the consequent double transmission of waves, some additional appliances are used, such as a sheet rubber diaphragm stretched behind the main diaphragm, to keep it always on the same plane, and a cushion of rubber effect in the contact point in front of the diaphragm, to make it yielding to the stroke of the diaphragm and thus prevent rebound.

This constitutes the transmitter, the musical tones being converted into electrical waves by singing into

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the tube and vibrating the diaphragm, to intercept the battery current at the contact points.

A cornet or other wind instrument, played in front of the tube, will vibrate the diaphragm equally well with the voice. The tone and intensity alone are transmitted by this instrument. The quality is lost.

The instrument by which these electric waves are reconverted into sound waves is based on an entirely new principle, being the first original discovery made by Mr. Edison, and alluded to on a preceding page of this book, and is called the Electro-Magnetograph. The active principle is that when a strip of paper or other absorbent is moistened in a solution of certain chemical salts and water (that most generally used being sulphate of soda), and subjected to the action of an electric current, a difference of friction is obtained—that is to say, the current appears to lubricate the paper and destroy its normal friction to a great extent. It will be noted that this difference of friction, being under the control of the electric current, an instrument constructed upon this principle may be controlled by the manipulator of the current at the distant station, making it possible to couple a lever or armature as absolutely as is done by the electro-magnet, but with this important difference, that the action being electro-chemical, no time is required to charge and discharge it, and it may therefore be operated with infinitely greater rapidity. By means of this great discovery the present systems of electro-magnetic telegraphy could be duplicated in their entirety if magnetism should suddenly become extinct or had never been discovered. Its adaptation to the telephone for the purpose of reproducing the sound waves is thus made. A small metal drum, flanged on both edges, is revolved by hand crank or otherwise, and carries over its surface a narrow fillet of paper which has been steeped in a chemical solution. An old style dalcmeir

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provides a sounding board of the best dimensions for the purpose. To this sounding board is attached a narrow brass arm, three inches in length, having affixed to it underneath a steel spring with platinum face, and through its end an adjustable screw, to force the spring downward, the arm projecting downward from the face of the sounding board, which is placed in an upright position. The revolving drum is fixed immediately beneath the end of this arm, the paper passed over the drum, and the platinum-faced spring forced downward upon the paper by means of the screw, with considerable pressure. The drum, revolving outward from the sounding board, drags the paper under the spring, the friction tending to draw the arm toward the drum. As the arm is rigidly attached to the sounding board, the board is bowed outward, and maintained in that position so long as the friction is imposed on the spring of the arm.

To release this arm and permit the sounding board to drop back and regain its normal position, and thus obtain a vibration, the electric current is made to pass through the paper at the point of friction by attaching the line wire to the arm and the earth wire to the drum. The forward motion of the drum being continuous, the friction is reimposed instantaneously upon the cessation of the current. This difference of friction at the point of contact between the spring and the paper is so instantaneous that the highest notes of the human voice are as accurately reproduced in the vibrations of the sounding board as if the voice itself were in the same room. The electro-magnet smooths the high notes; the electro-magnetograph has a capacity beyond the voice, and consequently records them faithfully.

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PUBLIC EXHIBITION OF THE EDISON SINGING AND SPEAKING TELEPHONE.

These exhibitions were originally undertaken by me at the instance of some friends of the inventor, and at the solicitation of the managers of the Permanent Exhibition, Philadelphia, all of whom were desirous of knowing more of his work, and of conveying to the public some idea of the wonderful inventive genius of this already renowned electrician and inventor, whose modesty has acted as a screen to hide him from the public gaze, while few meritorious talents has stalked abroad in the glorified day of the public prints and received their full merit of praise. The enormous demonstration at Philadelphia, where the people have assembled three several times to the number of from 5 to 8,000, indicated to my mind very clearly that a thirst for information upon the telephone subject pervaded the whole people, and determined me, in an already partly formed resolution, to organize a series of public exhibitions, in the form of a descriptive entertainment and practical demonstration of the capabilities of the invention. I have already given a number of these exhibitions at the various summer resorts, but solely with the singing instrument, and that, too, mainly in its earlier crude form. Experience with it has suggested many improvements, which, together with important additions made by Mr. Edison, now enhances its capacity for accurate reproduction of music in a pleasing and enjoyable manner.

In addition to this, however, my exhibits henceforth will include the *Speaking Telephone*, which will be exhibited in combination with the electro-magnetograph receiving instrument. In such manner as that articulated song, together with questions and replies, will be heard by the audience *en masse*.

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Also, the SPEAKING TELEPHONE

proper will be shown to those who desire to test it, upon the close of the entertainment.

The subjoined testimonials and Press comments are offered in confirmation of the assertion that these telephonic concerns are audible and enjoyable. Such assurance is considered necessary because of the very prevalent impression and belief that telephone music is too faint to be heard, except by an effort that robs one of the enjoyment, which impression doubtless comes from the rather ineffective character of the performances of other exhibited inventions, as well also from the natural realism with which the mind connects that sound coming from such a distance must be faint indeed. True, this is a false proposition, the sound not actually leaving the room in which it originates, but it nevertheless has its effect in influencing the mind in the direction indicated.

This hand-book is offered as a substitute for extended remarks in the course of an entertainment, in order that the demonstration of the working of the instruments may be more full and complete.

TESTIMONIALS.

We, the undersigned, being present at the Telephonic Concert given in the Horticultural Hall, West Chester, Pa., Sept. 29th, 1877, by Mr. Edward H. Johnson, with Prof. Thos. A. Edison's Singing Telephone, bear cheerful testimony to the fact that the performance was in every respect a complete success, the tunes played and song in Philadelphia being clearly rendered in our presence.

The large hall was well filled, and the notes were distinctly heard in all parts of it.

The explanatory lecture by Mr. Johnson was very full, and every question asked by the audience was promptly and clearly answered, rendering the evening's entertainment exceedingly enjoyable to every one interested in the progress of science.

THOS. V. COOPER, Senator,
J. BURGESS, Lawyer,
Wm. W. JERRON, Senator,
Eugene DICKERSON, Colonel,
W. H. DORE, Editor,
W. H. THOMAS,
G. M. PENLAND, Prof. B. N. A.,
JAMES S. BRYAN, Lawyer,
HENRY BROWN, Editor,
E. H. BROWN, Editor,
J. H. HARRIS, Prof. Teach.,
EDWARD W. LANE, Judge,
CHAS. LANE.

Chancellor

New York, Sept. 27th, 1877.

EDWARD H. JOHNSON, Esq.

Dear Sir:—The members of the Citizens' Association of Summit, N. J., request me to express their acknowledgments and sincere thanks to you for the compli-

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ment evening. The concert was given in the new Western Union building, at Tenth and Chestnut streets, Philadelphia, and heard distinctly at this end of the line, a distance of eighty-one miles. The prices that were sung, or rather harmonized, were heard almost as plainly as though the performers were in the room with the audience. The concert solos were particularly interesting. The performance upon this instrument was the last given, consisting of "Yankee Doodle," "My Maryland," "Columbia, the Gem of the Ocean," and other selections. It was an extraordinary feat.

Of a concert given at Atlantic City, 66 miles from Philadelphia, the *Atlantic City Review* of August 14th, 1877, says:

"The public demonstration of the Edison telephone attracted to Congress Hall last evening a large and highly intelligent audience, which manifested the deepest interest in the wonderful instrument. Prof. E. H. Johnson, a distinguished electrician of New York, explained, in a few terse, plain remarks, easily comprehensible by everybody, the mechanism by which the music is conducted and accurately reproduced so far away from the performers. His description was at once scientific and popular, and gave great satisfaction to those who came to learn the scientific working of the most extraordinary musical marvel of the time, as well as to gratify more curiously by hearing vocal and instrumental music sung or played over sixty miles distance. The first and a pin fall might have been heard while it was being listened to. The tune was immediately recognizable, and everybody in the hall was able distinctly to hear and repeat it. A burst of enthusiastic applause greeted it at the close of the piece. The volume of the sound was not large, and might be compared, perhaps, to the softer notes of a flute or clarinet, although in most of the notes the quality of the human voice was clearly perceptible. The concert music gave a decided suggestion of the clear, penetrating tones and facile execution which characterize that instrument in the hands of a good player. Several of the pieces were encored, and after Prof. Johnson had climbed back to Philadelphia the song and that an encore was demanded, the singer always replied,

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mentary exhibition of the wonders of the Edison telephone given at their village on the evening of the 28th inst., by which both vocal and instrumental music, received at the Western Union Telegraph building, in New York, was so perfectly and distinctly reproduced at our hall in Summit.

They desire also to testify to the peculiarly happy and intelligent manner in which you discussed on the telephone, by which the general principles of construction and action of this marvelous instrument were made so perfectly clear to the audience.

They feel grateful and justly proud that the most perfect success in public of the working of the telephone, and the first public exhibition of the Edison Singing Telephone should have occurred at our modest little village, and they hope that in the great success which the Edison telephone must undoubtedly achieve in the future, your name will always remain identified with it.

With many wishes for your future prosperity,
I am, dear Sir,

Respectfully yours,

JOHN H. JACQUELIN,
Chairman Ex. Com. Citizens' Association.

Of the exhibition at the Permanent Exhibition, Philadelphia, Aug. 2d, 1877, when the music was transmitted but five miles, the *Philadelphia Public Ledger* says:

"A number of songs and hymns were so clearly and accurately reproduced by the telephone as to be not only of any recognizable but enjoyable." *

Of a concert given at Cape May, N. J., 81 miles from Philadelphia, the *Cape May Press* says:

"A telephone concert was listened to by a large and intelligent audience in the east parlor of the Stickton

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When any special song was asked for by persons in the audience, the request was instantly telegraphed to Philadelphia and promptly responded to. It was altogether a marvelous performance, and, as one lady said, "it seemed like finding mysterious communication with the spirit land."

Of a concert given at Long Branch, N. J., 71 miles by wire from New York, the *Long Branch News* says:—"The telephone concert at the Ocean Hotel last evening was very successful. The audience was large and very high class, including many prominent persons. The music was transmitted from New York, and included Mr. D. W. McKenney, bassoon, of St. Peter's Church choir, Jersey City. A number of popular tunes were given, including the "Red, White and Blue," "Star Spangled Banner," "Last Rose of Summer," "I Dream I Dwell in Marble Halls," "Columbia, the Gem of the Ocean," "Sweet By and By," "Annie Laurie," a melody, and "Yankee Doodle." The notes were accurate and sweet. This instrument converses evening that Mr. Edison had just perfected an invention that will convey words as well."

Of a concert given at Saratoga, New York, 200 miles from New York city, where the singers were stationary, a lady correspondent, writing to the *Daily Saratogian*, says:

"The evenings have been enlivened with delicious music from the different bands, and a concert at the United States attracted all the elite of the house to listen to that wonder of the age, the singing telephone. Thus to annihilate both time and space, marks this wonderful invention as the greatest success of the nineteenth century. When the submarine telegraph first flashed its tidings from shore to shore we felt that indeed, little 'Puck's' aquatic bands had been foreshadowed! 'Till but a gentle sound the earth in its whirling little instrument to express the emotions and give pleasure to heart and soul, which, with its ramons of wars and pieces of stocks,

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can impart. One expresses utility, the other beauty. Like the masculine and feminine elements of life—the useful, grand and noble—the, boring, gracious and charming. But when words were spoken by the telephone, fluting in a second through two hundred miles away, there was something weird and almost uncanny about it. It was as if a telegram had come from some far-off planet, which, doubtless, future generations will enjoy, really in the dim, unfathomable future.

From the hall room of the States we stepped out into the inner court—a scene of enchantment, with the soft red light gleaming through the foliage, and listened to the *eurythmic* music of the land, and listened to the melody of the little electrical "singer." Gracing the scene were many charming women.

The *Savoyards*, referring to a third concert given Sept. 3, 1877, says:

"At the United States Hotel, yesterday evening, was given a sacred concert by means of Edison's singing telephone. The machine was located in the hall room, York city. There was a large attendance. The telephone operated very successfully, the sacred hymns being heard with greater distinctness than at either of the previous concerts. Among the pieces heard were, 'Hail the Fort,' 'We Will Meet Him at the River,' 'Coronation,' 'Sweet By and By,' and 'Old Hundred.' Another effort was made to speak through the telephone, the response being heard and understood in all parts of the large room."

Of a concert given at Albany, 150 miles from New York, subsequent to the above, the *Albany Times* says:

"A SEVERAL WHICH IS TO BE REPEATED.—The Old Hall presented an unusual scene last evening. A well filled house was assembled to listen to a concert, the music of which was transmitted over a single wire at a distance over 150 miles. The idea is in itself startling, and the fact could scarcely be believed if some of the tunes and songs played and sung at the Western Union Telegraph building in New York were distinctly heard

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and easily recognized, the notes at times becoming nearly as clear as if they came from voices and instruments on the stage. During the singing of one piece the toll of the voice was brought out very distinct and natural. "The instrument used was Edison's Singing Telephone." The instrument was constructed especially for the transmission of musical sounds. Mr. John H. Johnston, electrician from New York, explained the construction and working of it, giving useful and interesting information."

Of a concert given at Chester, Penna., the *Chester Times* says:

"THE TELEPHONE.—There was a large audience at the Holly Tree last evening, to hear the Edison telephone discourse music by telegraph from the Quaker City. Of course everybody had made up some kind of an idea on the subject; and upon the same hypothesis everybody was surprised, pleased and disappointed. No one had entertained a true conception of the real scientific treat that awaited them. Franklin surprised the world when he sent his kite into the clouds and brought down the lightning at his command. It was a wonderful thing when electricity was manufactured and sent whirling through men's bodies, twitching and jerking the limbs; it was the height of wonder when it was made the means of transmitting news from all parts of the world; now, when demonstrating that musical sounds and men's voices can be sent thousands of miles with correctness, we must not wonder when people say it is not yet perfect, that something more is to be accomplished, harnessed with a little thin wire, can be made to play 'Yankee Doodle' for the amusement of an audience without the possibility of a thunder gust, we say certainly feel safe and enjoy the closing with the good 'Old Hundred.' Edison is so far a success."

Of a concert given at Westchester, Pa., the *American Republican* of Oct. 9, 77, says:

"A successful exhibition of Edison's Singing Telephone was given at Horticultural Hall, Saturday night last. Vocal and instrumental music was transmitted

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over the wires with a distinctness and clearness truly amazing." * * *

Of a concert given in Jersey City, 90 miles from Philadelphia, where the singers were stationed, the *Jersey City Journal* of Oct. 30, says:

"The sounding board gave out the notes of 'The Sweet By and By,' very prettily and distinctly; the audience could hear it all over the house, and applauded enthusiastically." *

"In this manner were several tunes reproduced, without words, and with remarkable fidelity, inasmuch as notes could be distinguished from tenor, and tenor from soprano, etc. * * * A party in the telegraph office at Exchange place spoke and sang in a speaking telephone, and now and then a word could be distinguished in the Tabernacle, 'Glory! Glory! Hallelujah!' in song, and a sharp interjectory. 'How do you like it?' were heard quite distinctly."

JOHNSON'S WASHINGTON EXHIBITION OF TELEPHONE.

[From the "Evening Star," Washington, Nov. 17, 1877.]

An intelligent and appreciative audience assembled at the Congregational Church last evening to hear the Edison Telephone Concert. The music at Philadelphia was transmitted by telegraph and was very distinctly heard here. The concert consisted of music by Miss Taylor, soprano; Mr. Brisco, tenor, and Mr. Northcote, cornet, which was reproduced to the audience here with almost startling distinctness. Among those who were present was Vice President Wheeler, Secretary Thompson, General Butler, and other members of Congress, Judge Cortet and many other distinguished people, including Prof. Henry, who made a brief explanatory address with reference to the great progress in telegraphic inventions, &c., and then introduced Mr. E. H. Johnson, a telegraphic expert, who gave a concise explanation of the Edison Telephone used on this occasion.

The Baltimore signal station of the Weather Bureau on South street is supplied with speaking Telephone through which a conversation is carried on with the Washington office every evening. Last night this telephone was connected with the wires, and the Baltimore operators enjoyed the concert free of cost. ‡

The *Sun* says the atmosphere was clear and the music was heard distinctly. "Sweet Bye and Bye," "Then You will Remember Me," "Hold the Fort," and "My Maryland," were among the selections, with "Old Uncle Ned" as a cornet solo.

expert will readily recognize them, even when it would be difficult in practice for him to distinguish the simple tones; such a chord.

This method of showing the action of tones upon the human ear possesses the advantage of giving the clearest illustration possible of the entire process.

We may even understand by reference to fig. 3 why it is that the ear is so disagreeably affected by a chord.

It will be observed that the curves in the diagram represent the three characteristics of sound which have been referred to. The pitch is denoted by the number of vibrations or wave z recurring within a given horizontal distance; the intensity by the amplitude of the vibrations—that is their comparative height above or depth below the horizontal line—and the quality by the form of the waves themselves. It is therefore easy to understand that if, by any means whatever, we can produce vibrations whose curves correspond to those of a given tone, and if we can combine them so that the same impression will be produced, we have an ear that would have been produced by the original tone, which is the object of the composite.

The earliest experiments in the production of musical sounds at a distance by means of electricity, which, up to now, have been made in 1861 by Philip Reis of Friburg, in Baden, Germany.

His apparatus was constructed in the manner shown in fig. 4. A is the transmitting and B the receiving apparatus. Both are supposed to be situated at different stations. For the sake of clearness, the appliances by which the apparatus is arranged for reciprocal transmission in one direction or the other have been omitted. Furthermore, it may be well to state that, as the apparatus was constructed merely for the purpose of making known to a wider circle the discoveries which, and thus far, been made, the possibility of extending the action of the apparatus to a distance beyond the limit of the direct action of the current had not been taken into consideration. This is a mere question of mechanical construction, and has no special bearing upon the phenomena under consideration. The tone transmitter A, figure 4,

10 THE SPEAKING TELEPHONE.

is on the one hand connected to a metallic conductor with the same resistance as the receiver (fig. 1), efficient station, and on the other to the battery C and the arm of the return conductor. It consists of

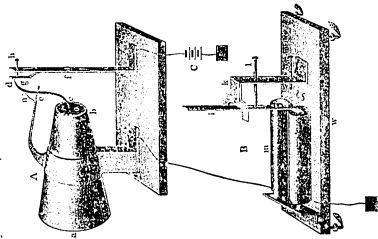


Fig. 4.

a conical tube, a, b , about 6 inches in length, and having a diameter of 4 inches at the larger and 1½ inches at the smaller end.

It was found by experiment that the material of which the tube was constructed had no influence upon the action of the membrane, and that the same is true as to its height. An increase in the diameter of the tube was found to impair the effect. The inner surface of the tube should be made as smooth as possible. The small re-entrant end of the tube is covered by means of a cylindrical membrane, a , against the ends of which rests one extremity of the lever $e d$, which lever is in vertical connection with the mechanical connecting wire through the plate c and supporting brackets. The proper length and proportion to be given to the respective arms $c e$ and $d e$ of the lever $e d$ is determined by the necessary movement at e with the best possible exertion of force at d . The lever itself should be made as light as possible, in order that it may follow with certainty the movements of the membrane, as any delay in its respect will give rise to a false tone at the receiving station. When the apparatus is in a state of rest the contact at d is closed; in a definite spring n maintains the lever in this position. To meet the standard f is connected with the battery B . The other end of which is connected to the earth. The return wire leading to the other station. A sliding contact g is attached to the standard f , and is provided with a contact point corresponding to that at d upon the lever $e d$. The action of this contact point may be adjusted by means of a screw h .

In order to prove that the interference occasioned by the action of the sporadic vibrations of the atmosphere upon the back of the membrane, when making use of the apparatus, is a negligible quantity, a disk about twenty inches in diameter upon the tube $a b$, in the form of a collar or flange, at right angles to its longitudinal axis.

The tone receiver B , d_2 , z , consists of an electro-magnet mounted upon a sounding box or resonator m , and is placed in the circuit of the electrical conductor from the transmitting station. Facing the poles of the electro-magnet is an armature

which is attached to a rod and bent into a light plate, z , which should be made as flat as possible. The lever and armature are supported from the magnet d_2 by a rod z in the manner of a pendulum, its motion being regulated by the adjusting screw l and the spring s .

In order to increase the volume of sound, the tone receiver may be placed at one of the focal points of an elliptical chamber of metal box n , with the ear of the listener is placed at the other focal point.

The operation of the apparatus is as follows: When the different parts are in a state of rest the electric circuit is closed. If an alternate condensation and rarefaction of the air in the tube $a b$ is produced by speaking, singing, or playing upon a musical instrument, a pressure and motion is communicated to the membrane, and from thence to the lever $e d$, by which means the electric circuit is alternately opened and closed at d , each condensation of the air in the tube causing the circuit to be broken, and each rarefaction in the manner causing it to be closed. Thus the electrical magnetism of the apparatus at B becomes disturbed in the direction of the magnetic force, alternating between the direction of the force of the air contained in the tube $a b$, and consequently the number of the electro-magnetic vibrations corresponding to times of the same duration as the vibrations of the air in the tube $a b$, in which the armature is attracted, and in the vibrations of the latter to the surrounding atmosphere, which in turn conveys them to the ear of the listener.

It must never be admitted that with the dimensions which have been described the apparatus transmits vibrations with perfect fidelity, or if at any time the number and interval is somewhat incorrect, that it is their intensity or loudness. This may be increased by adjusting the contact point g to the standard f , in order to obtain a more perfect contact, and to avoid the further development of the vibrations.

It was in consequence of this defect in the apparatus that the more the electric vibrations of the original vibrations were distinguished with great difficulty—that is to say, the

sounds were heard with more or less indistinctness, for the reason that the character of each tone depends not merely upon the number of the sonorous vibrations, but upon their intensity or amplitude also. This also accounts for the observed fact that while chords and melodies were transmitted and reproduced with a surprising degree of accuracy, single words, as pronounced in reading or speaking, were but indistinctly heard, although in this case, also, the inflections of the voice, interrogative exclamation, etc., could be distinguished without difficulty.

Figure 5 illustrates another form of Reiss's apparatus.

A is a hollow wooden box, provided with two apertures, one at the top and the other in front. The former is covered with a membrane *S*, such as a piece of bladder, tightly stretched in a

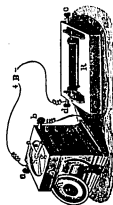


Fig. 5.

circular frame. When a person sings into the mouthpiece *M*, the vibrations of the air are concentrated in the front opening, the whole force of his voice is concentrated on the tight membrane, which is thrown into vibrations curves uniting exactly with the vibrations of the air produced by the sound of the singing. A thin piece of platinum is glued to the centre of the membrane and connected with the binding screw *a*, in which a wire from the battery *B* is fixed. Upon the membrane rests a little tipped *c/f/g*, of which the feet *e* and *f* rest in metal cups upon the circular frame over which the skin is stretched. One of them, *f*, rests in a mercury cup connected with the binding screw *b*. The third foot, *g*, consisting of a platinum contact point, lies on the strip of plati-

notice directly from the factory or work's office as readily as from the restaurant, and at such long distances (Figs. 24 and 25). Clearly, to illustrate the facility with which the invention may be maintained between office and factory, and plainly show its adaptability to all extent personal supervision may be exercised without any loss of time in the former figure the manager at his desk in the city is seen giving instructions to his foreman, who is shown at the works in the latter, carefully noting everything that is being said.

As a matter of prophetic interest, in connection with the telephone we feel constrained to reproduce here an extract from a popular little work, published a few years ago in France! The author, as will be seen, strikingly foretells the realization of the Speaking Telephone as it exists to-day, complete in everything but loudness of articulation. Speaking of the marvels in telegraphy, he says:

"Wonderful as are these achievements, the inventions in telegraphy have gone still further. To be able to transmit a thought to a distance is a triumph which was formerly unachievable; but we are now accustomed to it, and continue to practice it without its creating the slightest wonder. To be able to transmit hand-writing, and even drawings, appeared to be more difficult; but this problem has also been resolved, and we now hardly wonder that this feat is accomplished by means so simple. Mankind ever requires a new stimulus to its curiosity, and already is looking forward to the discovery of more marvels in telegraphy. Some years hence, for all we know, we may be able to transmit the vocal message itself, with the very inflection, tone and accent of the speaker. Already has the acoustic telegraph been invented; the principle has been discovered, and it only remains to render the invention practicable and useful—a result which, in these days of science, does not appear to be impossible.

Sound, of whatever kind is produced by a series of vibrations, more or less rapid, which, setting out from a somewhat

See Description of the Telegraph, par L. BAILLIE. Paris, 1873.

body, traverse the air and reach our ear. Just as a stone, dropped into a pool of water, sends a succession of circular undulations or water ripples, a vibration, acting on the air, produces analogous vibrations, though these are not visible, and it is when these vibrations reach the ear that they are sensible to sound. If, indeed, an eminent German scientist, has succeeded in human voice and determined its musical value. According to him each simple word is formed by one or more notes of this scale, accompanied by other and feebler notes which are harmonies of these. He demonstrates that it is the union of all these notes that give quality to the voice. Every syllable is formed by the notes of the vocal accomplished by different movements of the organs of the mouth. If, indeed, reflecting upon this, think, it would be possible to construct a human voice by artificially producing and combining the elementary sounds of which it is composed. This is not the place to discuss such theories, but if we grant that there is any truth in them, we can understand that the acoustic telegraph can be invented and can transmit the living voice. Already experiments have been made in this direction.

A vibrating plate produces a sound, and, according to the regularity of the vibrations, these sounds are sharp or flat. At each of the vibrations the plate sends a small point placed in front of it, and this cone is subject to throw the current into the line of the wire. When the plate ceases to vibrate and returns to its position of equilibrium, the smaller cones, at the next point, the current is consequently interrupted. By this means is obtained a series of interruptions, more or less rapid, according to the sound, the current being thrown into the line and interrupted once for each of the vibrations.

At the extremity of the line the current enters an electromagnet, which attracts another vibrating plate of size and quality identical with the former. Attracted and repelled very rapidly, exactly, and as rapidly in fact as the plate mentioned above, this second plate gives forth a sound which will have the same musical value as that of the other, as the number of vibrations per second is the same in both cases.

Should this process be perfected it will be possible to transmit sound by means of the telegraph—to transmit a series of sounds, a tune, or spoken sentence and conversation. This consummation has not, however, been yet attained. Many experiments have been made, the principle has been applied in direct ways, and everything makes us hope that we will yet arrive at a perfect system of acoustic telegraphy. Advances have been made very far upon the road to success. A series of vibrating plates, in-serting to the strings of a harp, has been arranged, each of which vibrates when struck by a particular sound, and sends off electricity to vibrate at the end of a line the same vibrations in a corresponding plate, or in other words, to reproduce the same sound.

This system, it must be admitted, is at least very ingenious. Experiments have been made in laboratories that is to say under conditions entirely fictitious, and such as we would not often find in actual practice. Under these conditions a musical air has actually been successfully transmitted by this acoustic telegraph. All must admit that this is a promising beginning; but we must not make too much haste to exact the miracle and to extol the advantages of the future machine, or to attribute ourselves the indulgence in infatuation and in audacity on the strength of this new discovery. That would be to give justice and an injury to science. True scientific faith is not content with the truth appears in uncontrovertible clearness. One must be taken not to take for reality that which is merely a desire on our part. We must guard against all premature exultation, because it weakens us in the search for truth, and because even one deception is cruel. Let us therefore give to doubt, to justice and to perseverance, the place which some too readily give to exultation."

CHAPTER VI

EDISON'S TELEPHONIC MESSAGES

The following account from Mr. Thomas A. Edison gives a detailed account of his researches in telephony, and is a valuable contribution to the history of the development of the speaking telephone.

Some time in or about the month of July, 1875, I began experimenting with a system of multi-le telegraphy, which had for its basis the transmission of acoustic vibrations. Being familiar, at the same time, by Hon. William Otis, President of the Western Union Telegraph Company, with a translated description from a foreign scientific journal of Rees's telephone, I also began a series of experiments with the view of producing a set of telephonic currents on the lines of the Western Union Telegraph Company, and of transmitting them simultaneously by the aid of a relay.

With regard to the multiple telegraph I will mention the methods were devised, among which may be mentioned the transfer system. This consisted in combining a key-tuning fork with multiple forks, so arranged at two terminal stations, with contact springs leading to different Morse instruments, that the synchronous vibrations of the forks would change the main line wires from one set of instruments to other sets at both stations, at a rate of 120 times per second. With this rate of vibration the wire would be simultaneously disconnected at both terminal stations from one set of Morse signalling apparatus, and momentarily placed in alternate connection with three other similar sets of apparatus, and then again returned to the first set, without causing the apparatus to mark the absence of the current otherwise than by a perceptible weakening of the same.

¹ Zitiert in: *Technisch-physikalisches Telegraphen-Verfahren*, herausgegeben von dem Aufsicht von der Kaiserlichen Postverwaltung, Berlin, 1876, S. 103. (Für eine Beschreibung des Verfahrens vgl. die Beschreibung des Verfahrens, herausgegeben von der Kaiserlichen Postverwaltung, Berlin, 1876, S. 103.)

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By this means, therefore, four perfectly independent wires were practically created, upon which signalling could be carried on with any system which was worked no faster than the ordinary Morse system. Each of these wires was also duplicated and found to work perfectly upon a line of artificial resistance, thus allowing, with the ordinary apparatus, of the simultaneous transmission of eight different messages.

Notwithstanding the perfect success of the system upon an artificial line, it was, however, which possessed little or no electrodynamic capacity, I have never in practice been able to produce a sufficiently perfect compensation for the effects of the static charge

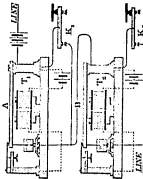


Fig. 103

to allow of the successful use of the system on a line of over forty miles in length, although I have put the line to earth at both stations after it leaves one set of instruments and before it is placed in contact with another set; have sent reversed currents into it, and have also used magnetic and condenser compensation in various ways, known to experts in static compensation, but all without avail. By vibrating a line wire between two sets of apparatus, however, good satisfaction has been obtained on lines of about 2-3 miles in length.

In the system of accurate transmission, which was devised in September, 1875, and is shown in Fig. 105, two tuning forks, A

and B, vibrating from 100 to 500 times per second, were kept in continuous motion by a local magnet and battery, and the short circuiting was controlled by the signaling keys K_1 and K_2 .

As will be seen on reference to fig. 10, this system, like the one seen on reference to fig. 8, is a direct-current system; the resistance occasioned by employing a movable electrical contact in the receiver is overcome by the use of a battery in the transmitter and which thus produces corresponding variations of the battery current in the line.

The receivers R_1 and R_2 , fig. 104, were formed of telescopic tubes of metal, by lengthening or shortening of which the column of air in either could be adjusted to vibrate in unison with the

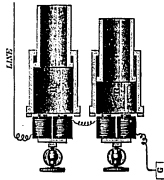


Fig. 104.

proper tone of the fork, whose signals were to be received by each particular instrument. An air diaphragm was soldered to one end of these tubes, and the latter placed in such a manner as to bring the diaphragm of each receiver just in front of an electro-magnet, which, in action, would cause them to vibrate. When the column of air in either receiver was properly adjusted to a given tone, the signals due to stopping and starting the vibrations by the distant key were very loud, as compared to other tones not in harmony with the column of air. Flexible rubber tubes, with ear pieces, were connected to the receivers, so

that, in using the instruments, the head of the operator was not required to be held in an unnatural or strained position.

This system worked very well; but one defect in it was apparent from the first, and that was its continual tendency to give the operator what is termed the back-stroke, even from the slightest disturbance, such as the opening of a door or the moving of the head and shoulders, and it sometimes happened that the operator was so much startled that he was unable to utter a word.

With a Morse sounder, as is well known, every dot is made apparent to the ear by two sounds, the first being produced when the lever strikes the arm, and the other when the arm strikes the upper or back contact. A dash, like the dot, is also made up of two sounds, but the interval of time between the production of the first, the downward stroke or sound and the upward stroke, is what determines its character. It frequently happens, however, when a sounder is so adjusted that the sound produced by the downward stroke is of the same volume or loudness as the one given by the up stroke, that the order of reading becomes reversed on the slightest disturbance or inattention and the ear mistakes the up sound for the down sound, and vice versa. The signals consequently become unintelligible, and the operator can only restore the proper order by closing both arms and watching the motion of the sounder lever, or by touching the back sounder by placing the finger on the lever until the ear again catches a word or two.

Similarity with the musical signals, the dots and dashes are found in the relative short or long duration of a continuous tone, but in this case the pitch is always the same, and this constitutes an element of confusion. It is just as bad as the back stroke of the sounder above referred to, therefore arranged my keys so as to transmit two short tones, and get together to form a dot, and two tones separated by an interval to form a dash. There was still so little distinctive difference between the two signals that I was led to defer further experiment with the apparatus for a time. It is probable that some means will be found for producing a greater degree of difference between the two elements of the signals, such, for instance, as the employment of two

factors of slightly different pitch, which, at least, promise well. When this is done the system will be of some value.

It will be noticed that the receiving instrument shown in figure 104 is the magneto-dial type, and that the magneto-dial is the speaking telephone. I never knew that I had made it was the first to devise apparatus of this kind, which I intended for in connection with acoustic telegraphs. I can, however, by making a connection with acoustic telegraphs, could be carried on between one receiver and the other upon the magneto principle by causing the voice to vibrate the diaphragm.

Another system of multiple transmission consisted, partly, in the use of reeds for receivers, and has been exceedingly well developed in the hands of Mr. Elisha Gray, but I forbear explaining it here, owing to its complexity and lack of practical merit.

My first attempt at constructing an articulating telephone was made with the Reiss transmitter and one of my resonant receivers described above, and my experiments in this direction, which continued until the production of my present carbon telephones, cover many thousand pages of manuscript. I shall, however, describe here only a few of the more important ones.

In one of the first experiments I included a simplified Reiss transmitter, having a platinum server facing the diaphragm, in a circuit containing twenty cells of battery and the resonant receiver, and then placed a drop of water between the points; the results, however, when the apparatus was in action, were unsatisfactory—rapid decomposition of the water took place and a deposit of sediment was left on the platinum. I afterwards used a platinum server, facing the diaphragm and the resonant receiver, and placed a drop of water between the points, with a very small drop of water (about half a drop) between the points, but the results were not much improved. Various acclimated solutions were then tried, but the confused sounds and decompositions were the only results obtained.

With distilled water I could get nothing, probably because, at that time, I used very thick iron diaphragms, as I have since

frequently obtained good results: or, possibly, it was because the car was not yet educated for this duty, and therefore I did not know what to look for. If this was the case, it furnishes a good illustration of the fact observed by Professor Mayer, that we often fail to distinguish weak sounds in certain cases when we do not know what to expect.

Springs, paper and felted, saturated with various solutions, were also used between the plates, and buff edges were substituted for the latter with no better results. Points immersed in electric oil, olive oil, etc., confined the experiments with various liquids, but no success was obtained until February, 1876, when I abandoned the decomposable fluids and endeavored to vary the resistance of the circuit proportionately with the amplitude of vibration of the diaphragm by the use of a multiplicity of platinum points, springs and resistance coils—all of which were designed to be controlled by the movements of the diaphragm, but none of the devices were successful.

In the spring of 1876, and during the ensuing summer, I endeavored to utilize the great resistance of thin films of platinum and white Arkansas oil stone, on ground glass, and it was here that I first succeeded in conveying over wires many articulated sentences. Springs attached to the diaphragm and numerous other devices were made to cut in and out of circuit more or less of the platinum film, but the disturbances which the devices themselves caused in the true vibrations of the diaphragm prevented the realization of any practical results. One of my assistants, however, continued the experiments without interruption until January, 1877, when I applied the peculiar property which semi-conductors have of varying their resistance with pressure, a fact discovered by me and others in 1873, in this case, some fibrous, or artificial, cables, in which were employed porous carbon, platinum and other materials in glass tubes.

For the purpose of making this application, I constructed an apparatus provided with a diaphragm carrying at its centre a yielding spring, which was faced with platinum, and in front of this I placed, in a cup secured to an adjusting screw, sticks of

circle plumbago, combined in various proportions with dry powders of carbon, graphite, and other materials. By this means I succeeded in producing a plumbago which gave great volume of sound, but its articulation was rather poor, when once familiar with its peculiar sound, however one experienced but little difficulty in understanding ordinary conversation.

After conducting a long series of experiments with solid materials, I finally abandoned them all and substituted thereof tufts of conducting fibre, consisting of floss silk entwined with plumbago and other semi-conductors. The results were then very much better, but while the volume of sound was still great, the articulation was not so clear as that of the magneto telephone of Prof. Bell. The instrument, besides, required very frequent adjustment, which constituted an objectionable feature.

Upon investigation, the difference of resistance produced by the varying pressure upon the semi-conductor was found to be exceedingly small, and it occurred to me that as so small a change in a circuit of large resistance was only a small factor, in the primary circuit of an induction coil, where a slight change of resistance would be an important factor, it would thus enable me to obtain decidedly better results at once. The experiment, however, failed, owing to the great resistance of the semi-conductors then used.

After further experimenting in various directions, I was led to believe I could by any one reduce the normal resistance of the semi-conductor to a few ohms and still effect a difference in its resistance by the pressure due to the vibrating diaphragm, that I could use it in the primary circuit of an induction coil. Having arrived at this conclusion, I constructed a transmitter in which a button of some semi-conducting substance was placed between two platinum disks, in a kind of cup or small containing vessel. Electrical connection between the button and disks was maintained by the slight pressure of a piece of rubber tubing, $\frac{1}{4}$ inch in diameter and $\frac{1}{2}$ inch long, which was secured to the diaphragm, and also made to rest against the outside disk. The vibrations of the diaphragm were thus able to produce the

requisite pressure on the platinum disk, and thereby vary the resistance of the button included in the primary circuit of the induction coil.

At first a button of solid plumbago, such as is employed by electrolyzers, was used, and the results obtained were considered excellent, everything transmitted coming out moderately distinct, but the volume of sound was no greater than that of the magneto telephone.

It occurred, therefore, to obtain disks or buttons, which, with a low normal resistance, could also be made, by a slight pressure, to vary greatly in this resistance. I have used a great variety of substances, such as conducting oils, sulphur, and other partial conductors, among which was a small quantity of lamp black that had been taken from a smoking petroleum lamp, and preserved as a curiosity on account of its intense black color.

A small disk made of this substance, when placed in the telephone, gave splendid results, the articulation being distinct, and the volume of sound several times greater than with telephones worked on the magneto principle. It was soon found upon investigation, that the resistance of the disk could be varied from three hundred ohms to the fractional part of a single ohm by pressure alone, and that the best results were obtained when the resistance of the primary coil, in which the carbon disk was included, was $\frac{1}{10}$ of an ohm, and the normal resistance of the disk itself three ohms.

Mr. Henry Bentley, president of the Local Telegraph Company, at Philadelphia, who has made an exhaustive series of experiments with a complete set of this apparatus upon the wires of the Western Union Telegraph Company, has actually succeeded in working with it over a wire of 720 miles in length, and has found it a practicable instrument upon wires of 100 to 200 miles in length, notwithstanding the fact that the latter were placed upon poles, and not across other wires, which occasioned sufficiently powerful induction currents to seriously destroy the articulation of the magneto telephones. I also found in the hands of Mr. Bentley that the instrument practicable, when included in a Morse

circuit, with a battery and eight or ten stations provided with the ordinary Morse apparatus; and that several way stations could exchange business telephonically upon a wire which was being worked quadruplex without disturbing the latter, and not withstanding, also, the action of the powerful reversed currents of the quadruplex on the diaphragms of the receiver. It would thus seem as though the volume of sound produced by the voice with this apparatus more than compensates for the noise caused by such actions.

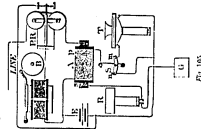
While engaged in experimenting with my telephone for the purpose of ascertaining whether it might not be possible to dispense with the rubber tube which connected the diaphragm with the rheotatic disk, and was objectionable on account of its tendency to become flaccid by continued vibrations, and thus necessitate the readjustment of the instrument, I discovered that my principle, unlike all other acoustical devices for the transmission of speech, did not require any vibration of the diaphragm—that, in fact, the sound waves could be transmitted into electrical pulsations without the aid of any intermediate medium.

The manner in which I arrived at this result was as follows: I first substituted a spiral spring of about a quarter inch in length, containing four turns of wire, for the rubber tube which connected the diaphragm with the disks. I found, however, that this spring gave out a musical tone which interfered somewhat with the effects produced by the voice; but, in the hope of overcoming the defect, I kept on substituting spiral springs of thicker wire, and as I did so I found that the articulation became both clearer and louder. At last I substituted a solid substance for the spring that had gradually been made more and more inelastic, and then I obtained very marked improvements in the results. It then occurred to me that the whole question was one of pressure only, and that it was not necessary that the diaphragm should vibrate at all. I consequently put in a heavy diaphragm, one and three quarter inches in diameter and one sixteenth inch thick, and fastened the carbon disk and plate tightly together, so that the latter allowed no vibration with the loudest voice.

Upon testing it I found my surmise verified: the articulation was perfect and the volume of sound so great that conversation carried on in a whisper three feet from the telephone was clearly heard and understood at the other end of the line.

This, therefore, is the arrangement I have adopted in my present form of apparatus, which I call the carbon telephone, to distinguish it from others. It is fully described in another part of this work.

The accessories and connections of this apparatus for long circuits are shown in fig. 195. A is an induction coil, whose primary



wire p , having a resistance of several ohms, is placed around the secondary, instead of within it, as in the usual manner of construction. The secondary coil s_2 of finer wire, has a resistance of from 150 to 200 ohms, according to the degree of tension required; and the receiving telephone it consists simply of a magnet, coil and diaphragm. One pole of the magnet is connected to the outer edge of the diaphragm, and the other, which carries the wire bobbin of about 75 ohms resistance, and is included in the main line, is placed just opposite its centre.

P. R. is the signalling relay, E. a Siemens' polarized instrument, which has been given a bias towards one side, and consequently is capable of responding to currents of one definite direction only.

The lever of this relay, when actuated by the current from a distant station on the line in which the instrument is included, closes a local circuit containing the vibrating call bell R, and thus gives warning when speaking communication is desired.

Besides serving to operate the call bell, the lever of E. is also used for sending the call signal. S is a switch, the lever of which, when placed at *a*, between *w* and *n*, disconnects the transmitter T and local battery E from the coil A, and in this position leaves the polarized relay P. R. free to respond to currents from the distant station. When this station is wanted, however, the lever S is moved to the position *n*, and depressed several times in rapid succession.

The current from the local battery, by this means, is made to pass through the primary coil of A, and thus for each make and break of the circuit a powerful current in the secondary *s*, which passes into the line and actuates the distant call bell.

When the call signals have been exchanged, both terminal stations place their switches to the right on *w*, and thus introduce the carbon transmitter into their respective circuits. The changes of pressure, produced by speaking against the diaphragm of either transmitter, then serve, as already shown, to vary the resistance of the carbon, and thus produce corresponding variations in the induced currents, which, acting through the receiving instrument, reproduce at the distant station whatever has been spoken into the transmitting instrument.

For lines of moderate lengths, say from one to thirty miles, another arrangement, shown in fig. 106, may be used advantageously. The induction coil, key, battery, and receiving and transmitting telephones, are lettered the same as in t. of previous figure, and are similar in every respect to the apparatus there shown; the switch S, however, differs somewhat in construction from the one already described, but is made to serve a similar purpose.

When a plug is inserted between 2 and 4, the relay or sounder R; battery E, and key K, only are included in the main line circuit, and this is the normal arrangement of the apparatus for signalling purposes. The battery, usually about three cells of the Daniell form, serves also both for a local and main battery. When a plug is inserted between 1, 2 and 4, the apparatus is available for telephonic communication.

I have also found, on lines of from one to twenty miles in length, that the ordinary cell can be dispensed with, and a simplified arrangement substituted. This latter consists simply

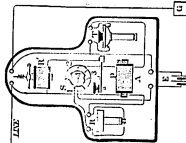


Fig. 106

of the ordinary receiving telephone, upon the diaphragm of which a free lever, L, is made to rest, as shown in fig. 107. When the induced currents from the distant station act upon the receiver R, the diaphragm of the latter is thrown into vibration, but by itself is capable of giving only a comparatively weak sound; with the lever resting upon its center, however, a sharp penetrating note is produced by the constant and rapid pulsations of the lever, which thus answers very well for calling purposes at stations where there is conjunctively but little noise.

Among the various other methods for signalling purposes which I have experimented with, I may mention the sounding of a note, by the voice, in a small Bell's telephone; the employment of a self-vibrating reed in the local circuit; and a break wheel with many cogs so arranged as to interrupt the circuit when set in motion.



Fig. 107.

I have also used direct and induced currents to release clock work, and thus operate a call, and in some of my earlier acoustic experiments tuning forks were used, whose vibrations in front of magnets caused electrical currents to be generated in the coils around the magnets.

By the further action of these currents on similar forks at a distant station, bells were caused to be rung, and signals thus

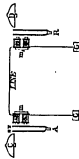


Fig. 108.

given. Fig. 108 shows an arrangement of this kind. A and B are two magnetized tuning forks, having the same rate of vibration and placed at two terminal stations. Electro-magnets m and m' are placed opposite one of the prongs of the forks at each station, while a bell, C or D, stands opposite to the other. The coils of the magnet are connected respectively to the line

wire and to earth. When one of the forks is set in vibration by a starting key provided for the purpose, the currents produced by the approach of one of its magnetized prongs towards the magnet, and its recession therefrom, pass into the line and to the further station, where their action upon causes the second fork to vibrate with constantly increasing amplitude, until the bell is struck and the signal given.

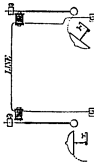


Fig. 109.

For telephonic calls the call bells are so arranged that the one opposite to the fork, which generates the currents, is thrown out of the way of the latter's vibrations.

Another call apparatus, which I have used, is represented in fig. 110. In this arrangement two small magnetized pendulums, whose rates of vibration are the same, are placed in front of

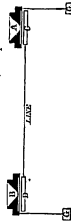


Fig. 110.

separate electro-magnets, the helices of which join in the main line circuit. When one of the pendulums is put in motion, the currents generated by its forward and backward swings in front of the electro-magnet pass into the line, and at the opposite terminal, acting through the helix there, cause the second pendulum to vibrate in unison with the first.

Fig. 111 shows a form of electrostatic telephone which acts

by the approach of the diaphragm contained in A or B towards or its recession from a highly charged electrophorus, C or D. The vibrations of the transmitting diaphragm cause a disturbance of the charge at both ends of the line, and thus give rise to faint sounds. Perfect insulation, however, is necessary, and other apparatus can be used both for transmitting and receiving, but the results are necessarily very weak.

Another form of electro static telephone is shown in fig. 111. In this arrangement Dolec piles of some 20,000 disks each are contained in glass tubes A and B, and conveniently mounted on glass, wood or metal stands. The diaphragms, which are in electrical connection with the earth, are also placed opposite to one pole of each of the piles, while the opposite poles are joined together by the line conductor. Any vibration of either dia-

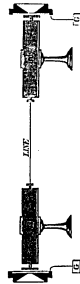


Fig. 111.

phragm is thus capable of disturbing the electrical condition of the neighboring disks, the same as in the electrostatic telephones; and consequently the vibrations when produced by the voice in one instrument, will give rise to corresponding electrical changes in the other, and thereby reproduce in it what has been spoken into the mouthpiece of the former.

With this arrangement fair results may be obtained, and it is not necessary that the insulation should be as perfect as for the electrophorus apparatus. Fig. 112 shows a form of electro-telecommunication, referred to near the beginning of this communication, by means of which I attempted to transmit electrical impulses of variable strength, so as to reproduce spoken words at a distance. Small resistance coils—1, 2, 3, etc.—were so arranged with connecting wires near a platinum fixed lever

B, in connection with the diaphragm in A, that any movement of the latter caused one or more of the coils to be cut in or out of the primary circuit of an induction coil C, the number, of course, varying with the amplitude of the vibrating diaphragm. Induced currents corresponding in strength with the variations of resistance were thus sent into the line, and could then be made to act upon an ordinary receiving telephone. By arranging the

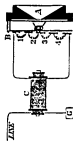


Fig. 112.

coils in a radiating pattern about a circular lever, I have succeeded in transmitting articulate messages by this method, but the results were very faint and disagreeable.

Fig. 113 shows a form of the water telephone previously referred to, in which a double coil was used so as to afford considerable variation of resistance for the very slight movements

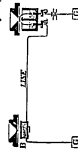


Fig. 113.

of the diaphragm. The action of the apparatus will readily be understood from the figure, where a wire in the form of the letter U is shown, with the bend attached to the diaphragm, and its ends dipping into the separate cells, and thus made to form part of the circuit when the line is joined to the instrument at a and c.

I am now conducting experiments with a thermo-electric tele-

phone, which gives some promise of becoming serviceable. In this arrangement a sensitive thermo pile is placed in front of a diaphragm of vulcanite at each end of a line wire, in the circuit of which are included low resistance receiving instruments. The diaphragm upon which the apparatus works depends upon the electric current produced in the vibrating diaphragm, which I have found is much better than the latter moves forward, and is also correspondingly increased on the return movement.

Sound waves are thus converted into electric waves of similar characteristic variations, and I am in hopes that I may ultimately be able, by the use of more sensitive thermopiles, to transform these heat waves into electrical currents of sufficient strength to produce a practical telephone on this novel principle.

Before concluding, I must mention an interesting fact connected with telephonic transmission, which was discovered during some of my experiments with the magneto-telephones and which is this, that a copper disk may be substituted for the iron diaphragm now universally used. The same fact, I believe, has also been announced by Mr. W. II. Preece, to the Physical Society, at London.

If a piece of copper, say one sixteenth of an inch thick and three fourths of an inch in diameter, is secured to the centre of a vulcanite diaphragm, the effect becomes quite marked, and the apparatus is even more sensitive than when the entire diaphragm is of copper. The cause of the sound is due, no doubt, to the production of very weak electrical currents in the copper disk.

Telephone Interferences [Volume 3]

Evidence for Voelker, Irwin, Gray, McDonough, Blake and Bell

Only the table of contents of this volume has been filmed.

THE
SPEAKING TELEPHONE
INTERFERENCES.

Cases A to L, and No. 1.

VOL. III.

EVIDENCE FOR
VOELKER, IRWIN, GRAY, McDONOUGH,
BLAKE AND BELL.

INTERFERENCES A TO L, AND NO. 1.

VOL. III.

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[illegible]

United States Patent Office.

TELEPHONE INTERFERENCES, A-L and No. 1.

MEMORANDUM.

The parties to these interferences who have taken testimony have been represented therein by the following counsel:—

A. G. BELL and FRANCIS BLAKE, *by J. J. Storror and W. H. Swan.*
ELISHA GRAY, *" W. D. Baldwin.*
T. A. EDISON, *" L. W. Serrell.*
A. E. DOUGLASS, *" F. L. Page and A. P. Brown.*
J. W. McDONOUGH, *" N. C. Gridley and W. G. Hicks.*
J. H. IRWIN and W. L. VOELKER, *" F. H. Betts and G. W. Dyer.*

The proof for Edison and for Voelker in A and B involved the same course of experimentation which was to be examined in the contest with Mr. Blake in No. 1; and as the counsel who represented Mr. Bell in A and B also represented Mr. Blake in No. 1, it was agreed that the evidence on all these issues might be taken at the same time and go into the same record.

The following stipulation was filed:—

TELEPHONE INTERFERENCE No. 1.

Voelker — Irwin — Blake — Edison.

TELEPHONE INTERFERENCES A AND B.

Voelker — Douglass — Gray — Berliner — Edison — Bell.

PHILADELPHIA, March 13, 1880.

It is stipulated in the above interferences that Case No. 1 shall fall behind A and B in the dates of taking of testimony and the

TELEPHONE INTERFERENCES.

hearing, and that Edison may take his testimony in all of these cases at the same time, and that at the hearing the testimony in all these cases and the exhibits may be used in each case by any party to any of said interferences.

GEO. W. DYER, *for Voelker and Irwin.*

W. D. BALDWIN, *for Eliza Gray.*

P. L. POPE, *for Dolbear.*

J. J. STORROW, *for Bell and Blake.*

L. W. SERRIALL, *for T. A. Edison.*

The record for Gray (printed in this volume) contains the following stipulation:—

"Counsel for Gray offers in evidence the record in the case of Bell Telephone Co. *et al.* v. Peter A. Dowd, in the Circuit Court of the United States for the District of Massachusetts, commonly known as the "Telephone suits"; and each deposition or piece of evidence embodied in or constituting a part of said record will be relied upon as if taken in these interferences, and may be so used by any party hereto. He also offers to recall for further cross examination, at any time during the present taking of testimony on behalf of Gray, any witness whose deposition was taken on behalf of the defendant in said suit, if such recalls be requested by any other party.

Agreed to by the undersigned, each for the interferences to which he is a party.

W. D. BALDWIN, *of Counsel for Gray.*

J. J. STORROW, *for Bell, Berliner and Bell Telephone Co.*

LEWIS W. SERRIALL, *Attorney for T. A. Edison et al.*

GEO. W. DYER, *for Voelker.*

FRANK L. POPE, *for Dolbear.*

GUTHRIE & Co., *for McDonough.*

"Counsel for Bell gives notice that he will recall for further cross examination, during the time allotted Mr. Bell for taking testimony in chief in these interferences, any witness whose deposition was taken on behalf of the plaintiffs in said suit, upon reasonable request for such recall from any party to these interferences.

J. J. STORROW, *for Bell.*"

MEMORANDUM.

The printed evidence in these interferences consists of the following:—

Vol. I. Proof for T. A. Edison. Depositions.

Vol. II. (4to.) Proof for T. A. Edison. Exhibits, drawings, applications and documentary evidence.

Vol. III. Evidence taken by all the other parties for this interference. It is machine-paged consecutively, and this paging is to be used in the trials, etc., unless otherwise specially stated.

In addition to this, the whole of the evidence in the suit Bell Telephone Co. v. Dowd, in United States Circuit Court for the District of Massachusetts, is introduced as original evidence herein by stipulation. It consists of two printed volumes. Vol. I. contains pleadings and depositions; Vol. II. contains documentary evidence and exhibits.

Telephone Interferences [Volume 4]

Briefs for Alexander Graham Bell and Francis Blake, Jr.

The table of contents, and those portions of the briefs which summarize Edison's case, have been filmed.

Lemuel A. Bell

United States Patent Office.

THE SPEAKING TELEPHONE INTERFERENCES

A-L AND No. 1.

BELL.

McDONOUGH.

GRAY.

VOELKER.

EDISON.

IRWIN.

DOLBEAR.

BLAKE.

LONG'S
BRIEFS FOR

ALEXANDER GRAHAM BELL

AND

FRANCIS BLAKE.

CHAUNCEY SMITH,
JAMES J. STORROW,
Of Counsel.

BOSTON:
ALFRED MUDGE & SON, LAW PRINTERS, 24 SCHOOL STREET.
1881.

United States Patent Office.

THE SPEAKING TELEPHONE INTERFERENCES A-L AND No. 1.

BELL.	McDONOUGH.
GRAY.	VOELKER.
EDISON.	IRWIN.
DOLBEAR.	BLAKE.

BRIEFS FOR

ALEXANDER GRAHAM BELL
AND
FRANCIS BLAKE.

CHAUNCEY SMITH,
JAMES J. STORROW,
Of Counsel.

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THE INVENTION OF THE ELECTRIC SPEAKING TELEPHONE.

BRIEF FOR ALEXANDER GRAHAM BELL

IN THE

SPEAKING TELEPHONE INTERFERENCES A—L.

SUMMARY.

Alexander Graham Bell's patent 174,465, issued March 7, 1876, disclosed a method of and an apparatus for the transmission of articulate speech by electricity. The apparatus consisted of a line wire with certain instruments at each end. The vocal organs of the speaker produced in the air those vibrations which constituted the particular sound he uttered. These vibrations produced corresponding motions in the mobile part of the transmitter. These motions, by suitable electric contrivances, gave rise to electric variations which corresponded in every particular with the peculiar, intricate and ever-changing motions taken up by the transmitter from the unbroken but ever-changing sound waves. These variations, caused at one end of the line, passed unchanged to the other. They there caused, or were there reconverted into, motions of a material body of extended surface, which in the variety and character of its movements exactly conformed to the variety and character of the electric variations which shook it. This extended surface in turn communicated its motions to the air, and the sound waves thus caused fell upon the ear of the listener (pp. 45-51, *infra*).

By this chain of causation it came about that the sound waves at the receiving station were the same in character as those at the transmitting station, and thus the same sound which was uttered into the instrument at one end was heard to proceed from the other. The claim granted to Mr. Bell thereupon was as follows:—

* The references, unless otherwise stated, are to the pages of this pamphlet.

"The method of and apparatus for transmitting vocal or other sounds telegraphically as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying said vocal or other sounds, substantially as set forth."

Substantially what was set forth was that the sound waves themselves produced corresponding motions in the transmitter; that these motions produced electrical variations exactly corresponding in the sequence and character of their changes, and that these were reconverted, without loss of character, though with some dissipation of energy, into similar air vibrations at the receiving station. No one had ever done this, and no one had ever reached the results obtained by it (pp. 51, 52).

Long before Mr. Bell's time, the voice had been employed by Reia to produce some changes in the electric circuit, and thereby to produce some sound. But to the end that the same word uttered into the transmitter shall be heard and recognized at the receiver, it is needed, not merely that the transmitter shall exercise some control over the receiver, but that it shall control its motions in these particulars which distinguish the vibrations belonging to one word or articulate sound from those belonging to another; and as, when electricity is employed, the connection is established by electrical variations caused by one end operating the other, it is essential that the transmitter shall not merely produce some electrical variations, but that it shall produce variations which correspond to those features of air vibrations which enable the ear to distinguish one word from another (pp. 50, 77, 80-82).

What are these features?

Sound is due to a minute vibratory movement of the air particles to and fro in a straight line between the speaker and the listener. Each particle engaged in this flux and reflux will start from a position of rest as at *c*, and vibrate along



a path between *a* and *b*. In successive vibrations its total length of path may vary; it may also perform its total vibration in a longer or shorter period. But besides these, and even if its length of path and period be fixed, it may pass over the path each time in a differ-

ent manner. It may go at a uniform speed; it may at every instant vary its speed, now above and now below the mean; it may progress part way, return on its path and then hurry on to make up for lost time. It is thus obvious that there may be an enormous variety in the manner in which it performs a vibration, as well as in the period employed, or in the total space passed over.

The total length of path or amplitude of vibration determines the loudness of the sound; the period of vibration, or the number of total vibrations per second, determine the pitch; the character, or as it is called, the *form* of the vibration determines what is called the *quality* of the sound, — that is to say, determines the characteristics which enable the ear to distinguish from each other sounds which are the same in loudness and pitch, as the human voice from a musical instrument, one voice from another, one articulate word from another. It is this, called *character* or *quality* in the sound, and *form* in the vibration, which is referred to in Mr. Bell's claim (pp. 38-48).

It is manifestly true of such a vibration, and of a current which in its rise and fall of strength is to correspond thereto, that we shall not determine its character or *form* by controlling it at its maximum and its minimum simply (pp. 42-44, 56, 77). The control must be continuous during the interval between the two. To impress this character on an electric current, it will not serve to interrupt it from time to time; it must never be interrupted, and the transmitter must control it without any cessation whatever; nothing less will suffice. No circuit-breaker can transmit speech, for when it breaks the circuit it loses control over the current, and therefore over the receiver. This is recognized in this case, and is now an accepted law of science.

It is also known that Reia, the most persistent experimenter upon the electrical production of sound before Mr. Bell's time, did not transmit speech, and that he used a circuit-breaker (pp. 82-88). We now understand why he failed. He did not know of the true method, first disclosed by Mr. Bell (pp. 88-97).

The changes and variations which the speaking telephone is to take note of and be operated by, and the electrical forces by which it is to be actuated, exceed in the rapidity of their sequence, and in the minuteness of their range and strength, anything theretofore

known in the arts. One of the chief troubles the mind encounters in dealing with it lies in the difficulty of grasping what almost eludes our power of conception (pp. 56-58).

Mr. Bell pointed out that a hitherto unthought of correspondence of operating sound vibrations and resulting current variations at one end and operative current and resulting sound vibrations at the other would enable speech to be transmitted. It is obvious that his results are reached, by means of his invention, if this correspondence be employed, no matter what changes, subject to that limitation, be introduced into the respective parts of the apparatus; and it has been decided that Mr. Bell's invention and claim, supported by one form of competent apparatus, is broad enough to cover and in law ought to cover all other forms which operate as we have described. *Gray v. Bell*, 15 O. G. 710 (1879); *Am. Bell Telephone Co. v. Spencer*, 20 O. G. 299 (1881). See pp. 23-54.

The strength of an electric current depends upon the amount of electric energy which is poured into the circuit, and the amount of electrical resistance which it there encounters; for the energy which is expended in overcoming resistance is not manifested as current strength. The relations are expressed by the following statement commonly known as Ohm's law: —

$$\text{Current strength} = \frac{\text{Electro-motive force}}{\text{Resistance of the circuit.}}$$

The desired current variations can be produced by employing the motions of the transmitter to vary the electro-motive force, or to vary the resistance, or increase in size having the same effect as a diminution of the other. The earliest type of the transmitter to vary the electro-motive force is the well-known magneto instrument. The earliest variable resistance transmitter is the liquid transmitter; the best known forms of it to-day are the carbon telephones and the articulating microphone. Mr. Bell's specification exhibits both the magneto transmitter and the liquid transmitter (pp. 53, 175).

So startling a novelty as the electrical transmission of speech would at once arrest the attention of those who looked only at its result and its value, and equally of those who could appreciate the

difficulties to be encountered, and the perfection and ingenuity of the method by which they were overcome (pp. 25, 26, 234, 255). Mr. Bell exhibited his apparatus at the Centennial Exhibition. On June 25, 1876, he transmitted speech by it in the presence of the judges and about fifty other persons, including the Emperor of Brazil, who listened at the instrument and repeated to the audience what he heard. During the following week the judges mounted the apparatus in their own pavilion, and carefully studied and experimented with it. The result was that the two reports described the success with which articulation was transmitted, and said that what he had done was "the greatest marvel hitherto achieved by the electric telegraph"; that "Mr. Bell exhibits apparatus by which he has achieved a result of transcendent scientific interest, — the transmission of spoken words by electric currents through a telegraph wire."

These reports were drawn by Prof. Joseph Henry and Sir William Thomson, and the letter said on the same day of Mr. Bell's work that "what yesterday he would have declared impossible he to-day had seen realized" (pp. 27-29).

From that time forward the whole community, lay and scientific, the newspapers and the journals of science, re-echoed the announcement that Mr. Bell had actually achieved a wonderful thing, heretofore entirely unknown and unaccomplished by others (pp. 29-31).

He devoted himself to the improvement of his instrument; during the summer and fall he brought them to a satisfactory condition for commercial use, and patented these improvements (No. 186,757, Jan. 30, 1877). He made them practically known to the community by public explanations and lectures, public exhibitions and public use, including the transmission of newspaper despatches. Early in 1877 a company was formed and they were put upon the market. By Aug. 1, 1877, about 1000 were in actual commercial use, and the factory was turning out 600 a month (pp. 31-33).

Up to this time Mr. Bell had everywhere been hailed as the true, first and original inventor of the new art. His present opponents, for the most part, expressly acknowledged his right. Mr. Gray himself took part in the exhibition of June 25, 1876, listened at the receiver, repeated to the audience the words he heard, and witnessed their applause.

In the summer of 1877 the Western Union Telegraph Company, owner of most of the telegraph lines of the country, found that the instrument had reached such commercial importance that it wanted to possess it. It therefore took the course of purchasing from Mr. Gray and Mr. Dolbear whatever work they had done that was supposed to bear upon it; and, already owning Mr. Edison's electrical inventions, it set up these gentlemen as prior inventors. This was the first attack on Mr. Bell. Considering why it arose and when it arose, it cannot be better described than in the words Watt used in writing to Houston, Sept. 6, 1778: "Every man who elicits as discoverer is in order to justify himself" (pp. 33-36).

To attack Mr. Bell's patent at this period for the first time, a contestant must show that he had accomplished success by the actual transmission of speech before the date of Mr. Bell's first patent; that he had an adequate conception of the invention before Mr. Bell's complete conception and disclosure thereof to Dr. Blake, which was in October, 1874, and had followed up that conception by a diligent reduction to practice as an operative instrument before Mr. Bell's patent. The law requires this, and common-sense demands it. But whoever asserted such a claim at so late a day would also have to meet the inquiry why it was, if he had an operative apparatus so long ago, that it was never heard of before; or what kind of diligence it was that slept so long, was not disturbed by the honor awarded to Mr. Bell, and availed only when the commercial success of Mr. Bell was such as to stimulate, and the schemes of the Western Union Telegraph Company were such as to be helped by, those pretensions (pp. 36-38, 254-262).

Goodyear v. Day, 2 Wall. Jr. 298, GIER, J.: "When genius and patient perseverance have at length succeeded, in spite of success and scoffs, in perfecting some valuable invention or discovery, how seldom is it followed by reward! Every rule him of the honor, while speculators, swindlers and pirates rob him of the profits. Every unsuccessful experimenter who did or who did not come very near making the discovery now claims it. Every one who can invent an improvement or vary its form claims a right to pirate the original discovery." We need not summon Morse or Blanchard or Woodworth to prove that this is the true history of every great discovery or invention."

Howe v. Underwood, 1 Fish. 162. [The sewing machine.] SRAUSE, J.: "How invariable it is that after a great invention has

been brought before the world, has become known to the public, and been put in a form to be useful, that people start up in various places and declare that they invented the same thing long before! . . . These pretended prior inventors had thought of such a thing, perhaps, but they had never carried it to the extent of making it of practical utility, so that the world could obtain possession of it. But when they find that another has completed that which they had begun, they are astonished that they did not see—it think they must have seen—all that is necessary, and claim that they have invented it. After having seen what has been done, the mind is prophetic. I think that this is one of the cases in which several of the witnesses have been led into the illusion of believing that they knew before, what they have learned or been taught by Mr. Howe's invention and specification."

In considering those who present themselves as inventors only after the fact, against a patent for a great and startling invention, it has come to be an axiom of law, as it is of sound reasoning, that no deposition (especially of the claimant and the inmates of his house or his workshop) are of any avail to overcome the inferences which naturally arise from his failure to have given early public sign of such practical success as he must assert to maintain his case (pp. 254, 255).

Smith v. Day, 6 Fish. 452: "The presumption arising from silence where there is so much incentive to assert, an occasion to assert it, and the party intelligent, and the results certain if the facts warranted it, is in favor of more strength than any prepossession in number of witnesses and literal statements made by them in the case."

Inglen v. Suffolk Co., 4 Fish. 101: "The greater the importance of the invention the less probable that it achieved it, would have been laid aside and not extended itself to others interested in its use."

Howe v. Underwood, 1 Fish. 162: "Now, it is a little remarkable that a perfect sewing machine . . . never produced work that anybody ever used for any purpose whatever . . . that it was laid aside for years without producing either work or promoting itself in other machines ever after. This is a phenomenon that requires to be accounted for."

Obviously there has never been an invention to which, considering the ease of construction of the instruments and the startling and useful character of the results, these judicial rules would apply as strongly as to the speaking telephone (pp. 247, 254, 255).

THE CONTENDANTS.

Mr. Bell's Case. — He has a patent. We have seen what must be proved to prevail against it; and the proof here must be the same as in court. He is entitled to go back to the disclosure of his definite conception to Dr. Blake in October, 1874, because he pursued it with diligence until he obtained his patent. For the history of his work, see pp. 56-72, *infra*. The authorities show what is an adequate conception, what is a reduction to practice, and by what rules the law will ascertain the question of diligence, — whether there has been that diligence which enables the claimant in a contest on dates to connect his reduction to practice with an earlier conception (pp. 242, 244, 247). Mr. Bell's date is October, 1874.

Mr. Gray's Case. — In December, 1875, Mr. Gray saw a "lovers' telegraph," or string telephone. This led him to think whether the motion of a diaphragm could be utilized in an electrical apparatus with like effect. Feb. 11, 1876, he made a sketch for a liquid transmitter substantially like that of Bell's patent. On Feb. 14, 1876, this was reduced to the form of a "caveat" or statement of an incomplete invention not ready to be patented, and was deposited as such in the secret archives of the Patent Office. Mr. Bell's finished application was filed a few hours earlier. Mr. Gray's caveat gives abundant indications that his ideas were very vague, and that he then believed the single diaphragm instrument (the one now relied on) to be insufficient for the purpose (pp. 106-117).

He paid no more attention to the subject until June 25, 1876, at the Centennial, when he participated in Bell's exhibition, listening at the receiver and repeating to the audience what he heard (p. 172). He then for the first time tried to construct a speaking telephone, but utterly failed, and did not even preserve his model (p. 172). He made no more instruments, until, in connection with some lectures he gave in March, 1877, he asked Mr. Bell's permission to construct and exhibit a speaking telephone, *stating that he should exhibit it as Mr. Bell's invention*. In that correspondence and at that lecture he expressly stated that Mr. Bell was the first inventor. In a subsequent lecture in New York, in April, 1877, he stated to the audience that

Mr. Bell, who he said was then present in the hall, was the inventor of the speaking telephone, which must be distinguished from his own musical telephone (pp. 173-175).

Mr. Gray fails in all of the three things he must prove: priority of conception, reduction to practice, diligence to connect them (p. 178).

Mr. Edison's Case. — In August, 1875, Mr. Edison read a manuscript translation of a description of the Reis circuit-breaking instrument. He perceived that the apparatus could not transmit speech, and presently made on the back of the paper some rude pencil sketches of his ideas about a liquid transmitter connected with a receiver, which in fact is incapable of reproducing speech. He got no further than this sketch (accidentally preserved) until he heard of Mr. Bell's successful exhibition at the Centennial. He then took up the subject, and after some months of labor and experiment in different directions, constructed many models and one finished instrument. This was a liquid transmitter, and was made in October or November, 1876 (pp. 199, 200). It is the earliest of his telephones now in existence.

These facts and dates are abundantly proved by the depositions of his own witnesses. One of them, his assistant, Johnson, wrote a pamphlet in the early part of 1879, in Edison's behalf, for the purpose of stating his claims. This pamphlet was put in evidence by Edison, and states that Mr. Bell is the first inventor of the speaking telephone, and that Edison "took up the subject" after hearing of Bell's Centennial exhibition (pp. 188-190 *et seq.*).

Mr. Dolbear's Case. — During 1877, in private letters and in a printed publication, Mr. Dolbear expressly stated that Mr. Bell was the first inventor and constructor of the speaking telephone. He now testifies that he only claims certain improvements which he says were invented after August, 1876; that is, when Bell's patent was six months old (pp. 160-169).

Mr. Voelcker's Case. — In January, 1876, Voelcker first saw a string telephone and noticed that the voice made the diaphragm vibrate. He knew that the lever of a Morse receiver made a stroke each time the transmitting key was, by its motion, brought into contact with its stop, moved away, and thus closed and opened the

circuit; it occurred to him that if such a key could be attached to the membrane and thus worked by the voice, the sound of the voice would result at the other end. He was not sufficiently informed of the nature of articulation, nor of the failure of previous experimenters, to know that this operation was in its nature inadequate, and so he made an instrument which embodied this conception (pp. 128-130). Of course it was not a speaking telephone. This conception was "some time in January," and his first model was in the first part of March, 1876 (pp. 116-121). He made several instruments which embodied this idea. From all he obtained but one result: the voice or the sound of a musical instrument would produce a sound of corresponding pitch, but *quality* was not transmitted. His evidence is that during eighteen months of trial he almost invariably produced tones but nothing more. No witness proves the transmission of a single word; he himself thinks that at most he could recognize a few detached and familiar words out of a sentence in the course of hundreds of trials. He had in fact reinvented the Reis transmitter, and his whole history and results are consistent with that and inconsistent with anything else (pp. 122-124, 131).

In the fall of 1877 he attracted the notice of Mr. Irwin, of Morton, Pa., who had long known him, and Mr. Irwin invited him to bring his instruments to Morton. Mr. Irwin was an inventor, largely interested in patents, of ample means, and possessed of a finely appointed laboratory and machine shop for experimental work. He promised Voelcker that he would furnish means to patent whatever the latter had done in telephony, if he had done anything, and Mr. Irwin himself was about to turn his attention to telephonic inventions, because he felt satisfied that there was money to be made in that field. Voelcker brought his instruments to Irwin's laboratory, spent nearly a whole day trying them, reproduced tones very well, but was not able to transmit articulate words at all (pp. 132, 133). He exhibited and fully explained to Irwin all that he had done. Thereupon Mr. Irwin concluded that Voelcker had merely reinvented the Reis transmitter. For greater certainty, an eminent patent lawyer, who was counsel for Irwin in other matters, was consulted, and he gave a professional opinion that Voelcker had merely made a Reis transmitter. A few months afterwards another of Mr. Irwin's

solicitors, — the gentleman who has prepared all Mr. Irwin's and Voelcker's specifications on telephones, — being at Morton, where Voelcker then was, in Irwin's employ, examined Voelcker's work, talked with him fully about it, and again was satisfied that Voelcker had made a Reis transmitter (pp. 133-137). From that time on Voelcker did not touch his instruments until he prepared his application in 1879, when Mr. Bell's patent was more than three years old, and when more than 40,000 telephones were in use (p. 137).

We have stated (pp. 76, 87, 149, 326) what constitutes an articulating microphone, and on pp. 82-8, 149, what is a Reis transmitter. The difference is that the one works by varying the pressure at a contact which must be maintained unbroken, while the other operates by breaking the contact and circuit at each vibration (p. 149). Irwin and his advisers are proved to have understood the two instruments and this precise distinction between them, while Irwin expressly testifies that he perfectly understood the construction and operation of all Voelcker's instruments (pp. 135-6). The decision they arrived at, at the time, therefore (fall of 1877 and spring of 1878), about the true character of Voelcker's invention, has all the merits of a decision intelligently arrived at and acted upon against the interest of the parties, an admission by the inventor's assignee, and the strongest testimony that the description then given by Voelcker of his work excluded him from any claim that he had invented a speaking telephone (p. 134).

But irrespective of the character of his apparatus he cannot contend with Bell in dates.

Moreover, Bell's instruments had been publicly used and offered to the public for commercial use more than two years before the date of Voelcker's applications, which were in May and September, 1879 (p. 32). The motives for which and the extraordinary circumstances under which his work was then put forward for the first time are sufficient to condemn the attempt (p. 157).

IMPROVEMENTS IN SPEAKING TELEPHONES.

The broad claim referred to on p. 4, *supra*, belongs to whoever first invented the art or method and showed some apparatus by which

it could be practised. He is not an inventor unless he does both. He would be the first inventor of the method, and necessarily also the first inventor of the particular apparatus with which his method was connected in its origin. The next comer might invent a different apparatus, and until the history of the first has been developed it is conceivable, with regard to any particular form of instrument, that it may have originated with the second inventor. But it cannot be true of independent inventors (as distinguished from joint inventors), that one can have a valid patent for the method and another can afterwards obtain one as the first inventor of the first apparatus by which his earlier rival practised it (pp. 234, 267).

Nearly every detail or form of instrument employed in the speaking telephone is the subject of contest. The decision, however, that Mr. Bell holds a valid patent on the broad claim for the art or method necessarily establishes that he is the first inventor of the first form of apparatus he used. Indeed, they are so intimately connected that they cannot with propriety be placed in separate patents, even by the first inventor of both.

The contestant McDougall made an instrument with which he tried to transmit speech before Mr. Bell applied for his patent. McDougall has since filed an application in which he describes a "transmitting membrane" and a "receiving membrane," "electrical battery," "circuit wires," "armature," "magnet," etc., all of which, he says, are so arranged and connected that "the vibrations of the transmitting membrane or apparatus produced by articulate sounds are transmitted by the electrical current to the receiving membrane or apparatus, and so as to cause a like vibration of the receiving membrane or apparatus, and cause it to reproduce the articulate sounds transmitted from and by the receiving membrane or apparatus." His claim corresponds to this statement of invention (pp. 222, 223).

If he did make an apparatus which would practically do this, he made a speaking telephone, and would be entitled to a patent for it if he were the first, but upon inquiry, it turns out that his apparatus will not do this at all. His "transmitting membrane" breaks the circuit at each vibration. It will cause an equal number of vibrations in the "receiving membrane," but they will not be

"like" those of the transmitter. His receiving membrane did not have the "form of vibration" to which articulation is due, and his current was not capable of transmitting quality. His transmitter was a circuit-breaker, like that of Reis (p. 224). If he had obtained exactly the patent he asked for, it would have been void, because the described machine would have been inoperative. It is true that the parts would have moved and made a noise, but this is the case with most machines that have been condemned. It was inoperative in the sense of the law because it would not practically accomplish the only result for which it was constructed and tried (p. 237). That he was unable to perceive that success could not be attained by following out the conceptions he was working on made it none the less a failure.

Mr. McDougall says, however, that he finds in Mr. Bell's patent certain elements which he employed in his unavailing attempt, and he would now like to have Mr. Bell's patent defeated *pro tanto*, and a patent granted to him for those elements, and Mr. Bell's patent made subject to it. The elements of which he asserts this are the diaphragm, armature and magnet which constitute the receiver of Mr. Bell's patent. It is obvious that if he can do this, he, who failed to make a speaking telephone, will, out of that failure, control and thereby acquire a very great share of the profits of the speaking telephones which he was unable to construct, and thereby reap a crop he did not raise (p. 235).

Now, apart from the question of dates, and the question of defendant, there are two answers to these pretensions.

Mr. Bell discovered, and, in his patent showed, that a certain combination of magnet, diaphragm and armature, when arranged in specified connection with other specified parts, constituted an apparatus which would transmit speech. Before the date of his specification no one had done this or had known it. Each subcombination was his original invention, and formed part of his earliest conception and earliest construction. Now several contestants came before the Office with applications which describe a device said to be the same as one of those subcombinations, and each asserts for that it will act as a receiving instrument to "reproduce" "quality," "oral conversations," and all sounds which may actuate a transmitter (p. 230). It

is apparent that the whole value of the device lies in this alleged capacity. The issues are based on these applications, and are in the language of the claims asked. It is obvious that these claims can neither be sustained, nor overthrown if granted, except by the production of an instrument which has this capacity.

After the grant of Mr. Bell's patent they bring forward these assertions to defeat *pro tanto* his right to "make, use and vend," for the purposes set forth in his patent, that which was first brought into the arts by his patent. Upon being asked whether they knew that the assertions of their applications are true, whether before the grant of Bell's patent they had, by actual use, demonstrated that they are true to the extent of producing practically useful results, each contestant is obliged to reply that his conception did not reach so far and that he made no trial which could give an answer to the question; but now, from reading Bell's patent, they say they learn that their models could answer this purpose. That does not make a case against a patent. (See pp. 288-296.)

Furthermore, in the case of McDonough, there is no proof in the record that the instrument he constructed ever did, or to-day can do, what is asserted; and whoever attacks a patent must prove this affirmatively (pp. 237, 238).

The courts have often had to deal with these attempts to set up old and unknown things to eat the life out of a patent which cannot be entirely destroyed, and as often they have decided that such things are as unavailing for one purpose as for the other.

Atlantic Powder Company v. Parker, 16 O. G. 455, BLATCHFORD, J.: "By the light of what Nobel has taught in the patent suit on, much can now be asserted to be seen in what was published before which no one ever in fact saw in it before the original of the patent sued on was taken out."

In *Hose v. Underwood*, 1 Fish. 162, the court had to deal with the Hunt sewing machine. It was an organized machine with the most prominent parts of Howe's in it, and it did make stitches. In the language of the court Hunt had "advanced so far that he made a machine that would, to a certain extent, sew." Upon this the Court said (p. 257, *infra*).

"However far it may have advanced, however many ideas may have been combined in it which, subsequently taken up, might, when perfected, make a good machine, still, not being perfected it has not come before the public as a useful thing, and is, therefore, entirely inoperative as affecting the rights of those coming afterwards. . . . If Mr. Hunt did not go to the extent of having perfected a machine, although he made many ingenious devices, it was in the eye of the patent law a nullity."

Aultman v. Holley, 1 Fish. 534, 11 Blatch. 317, WOODRUFF, J.: "The suggestion that where such experiments are made without resulting in a useful machine and the product thereof is abandoned on that ground, whatever devices it contained become public property, and can be dug up in after years and produced to defeat the patent of an independent and successful inventor is not, I think, sound or warranted by law" (p. 253).

Wyman v. Knobel, 15 O. G. 320, Com'y's, Dec. 1878, p. 39, SPEAR, C.: "Although this disconnecting mechanism which is the subject of the controversy performed its function well, yet if the machine in which it was embodied proved a failure, Wyman would not have been able upon that machine to establish his claim as the first inventor of the disconnecting mechanism against a party who had embodied the invention in a successful operating machine" (p. 244).

See these and other cases to the same point, pp. 249-254, *infra*. A speaking-telephone receiver is not a machine by itself. It is true that it can be detached from the wires, but it is not operative for any purpose whatever unless connected with a transmitter. It is not a machine, but an element in a machine (p. 235). The specification of Mr. McDonough recognizes this, for it describes it only as part of the whole, and neither of his claims refer to it except a claim on the whole described apparatus for the transmission of speech of which it forms a part (p. 236). The whole is in fact, as in law, a unit as much as the result which requires the co-operation and simultaneous action of all the parts in a unit.

It is true that, given the speaking telephone, one may have a patent for a new receiver, because the existing state of the art sometimes it into the system if the specification shows how to do it (p. 247); but at the time when McDonough says he made the invention the arts did not possess a speaking-telephone system, and he cannot take advantage of Mr. Bell's patent to produce the system, and then say that Bell did not produce it. (See pp. 20, 24, *infra*.)

Finally, however, McDonough cannot prevail on dates. He must go back of Mr. Bell's date of October, 1874. His story is that in 1867 he stretched a membrane on a hoop twelve inches in diameter, leamed it against a pile of books, placed an electro-magnet in front of it and interrupted the current by drawing the wire over the rough teeth of a rasp which formed part of the circuit. This apparatus was broken up. It was at most evidence of a conception of something, not of a completed invention. He did nothing more for eight years (except to make a pencil sketch in 1871), until in April, 1875, he heard of Mr. Gray's success (pp. 229-232). Under the authorities cited on pp. 244-246, *infra*, he is considered as one who began in 1875, because there is no diligence to carry him back to 1867. Moreover, giving due weight to the preliminary statement sworn to in 1878, there is no satisfactory evidence that he made any instrument until after Bell had made his instrument of June 2, 1875 (pp. 229, 234). It is certain that whenever McDonough made it he obtained only the results to be expected from a Reis circuit-breaker (p. 22).

Dolbear's Case.—Dolbear claims that he invented those two improvements in the speaking telephone which consist in the employment of a permanent magnet and a metallic diaphragm (pp. 160, 165). His first conception was Sept. 20, 1876, when he made a sketch in his memorandum book (p. 161), and a few weeks afterwards caused his assistant to begin the construction of a pair of telephones (p. 161), to be made with permanent magnets and stretched rubber diaphragms (p. 160). But these instruments were never made, so as to be tried, and their remains are not produced (p. 161). Some time after that he thought that metal diaphragms might probably be used (p. 167). His next instruments were begun after Christmas, 1876, and finished in February, 1877 (p. 167).

Mr. Bell made a magnetic receiver with metallic diaphragm in May, 1876, used it at the Centennial, and it is now produced in evidence (p. 110). It was also used as a transmitter in May, 1876 (p. 110). At the beginning of July, 1876, he made a soft iron diaphragm expressly to use as a transmitter, and did so use it (p. 110).

In October he made sets of finished instruments with metallic

diaphragms, used them extensively in November, showed the feature in a specification filed at London, Dec. 9, 1876, sent one of his working instruments to the Patent Office as a model, and obtained his patent Jan. 30, 1877 (pp. 109, 110), before Dolbear had made his first instrument with this feature.

Mr. Bell's original idea of October, 1874, was to use permanent magnets. Afterwards he apparently thought he would get more power with a battery. July 2, 1876, he wrote to a friend that he believed that a permanent magnet without a battery should be used, and he at once had such a magnet made, before July 15, 1876, to fit his existing instruments, and used it with success. He put another permanent magnet into a set of finished instruments in November, described it in his English specification of Dec. 9, had it in the working instrument filed in the Patent Office, and obtained his patent Jan. 30, 1877, before Dolbear had actually completed his first instrument (pp. 109, 110).

Mr. Gray also claims the metallic diaphragm. In 1874 and 1875 he made two instruments which contained an iron diaphragm and electro-magnet, and with them produced musical notes due to a strong battery current interrupted by an automatic circuit-breaker. He used them for experimental exhibition two or three times, but one and broke up the other, and never made others except for this controversy, in the fall of 1877 (pp. 177-184, 299-302).

In his present application he asserts that they can reproduce speech (p. 297); but he never demonstrated that they could, and never tried them for this purpose until long after Bell had publicly used his metallic diaphragm and patented it (pp. 182, 183).

That a metallic diaphragm could be used for this purpose came to him, from Mr. Bell, as a new revelation. In February, 1876, Mr. Gray prepared his speaking-telephone event. In that he in substance declared that his old instrument, which he now relies on, could not be used for a speaking-telephone receiver, but that the diaphragm of that instrument should be "of some thin substance, such as parchment or goldbeater's skin, capable of responding to all the vibrations of the human voice, whether simple or complex" (pp. 181, 182, 300-302).

Clearly his wash-basin of 1874 must be ranked among things abandoned and declared unfit for this purpose by their author.

Moreover, at the Centennial, Bell's instrument, at which Gray listened, had a metal diaphragm, but Gray never laid claim to it, then or subsequently, until the fall of 1877, when Mr. Bell had about 4,000 in public use (pp. 181, 183, 300, 301).

Mr. Edison also claims the metallic diaphragm, but stands on the same footing as Mr. Gray. The instruments he relies on (A and A') were made in November, 1875, to use with interrupted currents for musical tones merely, and the features which he intentionally introduced into their construction to fit them for that purpose unfitted them for speaking telephones (pp. 208-210). He made no use of them except for a few experiments in his laboratory. He did not demonstrate that they could reproduce quality. At the end of June, 1876, he heard of Mr. Bell's success, and took up the subject seriously (p. 189). It does not appear that he used his old instruments, but he tried some metal diaphragm receivers, and condemned them as worthless (p. 214). He then adopted parchment as the suitable material, and invariably used it until several weeks after Mr. Bell obtained his patent on it, and then, for the first time, he directed that either iron or parchment might be used (p. 215).

His work of July, 1876, is not early enough to affect Mr. Bell, and it is certain that he cannot connect his instruments of 1877 with his imperative and untold devices of 1875 by anything which the law would term diligence on the part of a man so well equipped for his work as Mr. Edison, in the face of such an invention as the speaking telephone (pp. 216, 302-304).

We now proceed to consider each interference separately.

THE INTERFERENCE ISSUES.

Interference A.—This turns upon the inquiry who first invented that method of transmitting speech by electricity which consists in causing electrical variations similar in form to the sound waves which produce them. The parties are the patentees, Bell, and the applicants, Gray, Edison, Dolbear, Voelker. For reasons stated on pp. 8-11, *supra*, priority must be awarded to Bell.

Interference B.—This raises the inquiry who first invented that

way of causing these articulating vibrations by employing the movements taken up from the sound waves by the trans-mitter, to vary the resistance of the circuit instead of varying the electro-motive force. The parties are the patentees Bell, and the applicants Gray, Edison, Voelker. Bell was the first to conceive and to patent. The others did not even follow up with diligence such early conceptions as they had. None of them had constructed an instrument when Bell's patent issued. For these three reasons priority must be awarded to Bell.

Interference C.—This rests upon the invention of the liquid transmitter as one means by which the movement of the diaphragm of a speaking telephone can be employed to vary the resistance of a circuit in a manner suited for the purposes named in B. The parties are the patentee Bell, and the applicants Gray and Bell. They rely on the same instrument and the same facts as in B, and for the same reason the decision must be in favor of the patentee Bell.

Interference D.—This turns upon the use of a small detail of mechanical construction in a liquid transmitter; an adjusting screw to move one of the electrodes. The parties are Edison and Gray.

Interference E.—“In an acoustic telegraph, an armature plate, the electro-magnet for the same, and a closed circuit passing from the helix of such electro-magnet to the source of oscillatory electric energy.”

“This is the subject matter of Edison's third claim, and is substantially described in the other applications, and the patent involved.”

The parties are Bell, patent 174,465; Edison, application 145; Gray application 3; Dolbear.

The Abbot L'Abbe's apparatus, described in Baile (vol. iii. p. 709), and Bourne's apparatus (vol. iii. p. 821), employed for receiver a flat plate of metal in front of an electro-magnet. Rapid alterations of current in the helix caused the plate to vibrate and produce a musical sound. That form of the Reis apparatus described by Legat (vol. iii. p. 261), employed an arrangement similar, but with a plate capable of producing all pitches of sound. Varley (English patent of 1870, No. 1044, Dwell Record, vol. ii. p. 552) utilized this class of instruments in his acoustic telegraph. He placed the helix of the receiver in the secondary circuit of an induction coil so

that it was always in a closed circuit. Its primary circuit was opened by the vibrations of a tuning-fork circuit-breaker, but, so far as the purposes of his harnais telegraph are concerned, it is quite immaterial whether the transmitter in that circuit be a circuit-breaker or not. In one form of his apparatus he replaced his transmitter by a magneto machine rapidly rotating. This necessarily employed a closed circuit, and this source of electric energy threw on the line a varying and uninterrupted current. The language of the issue, taken by itself, would, without doing violence to the words, include the apparatus we have described, and we must therefore look for a different meaning.

But the Varley apparatus did not enable the operator to give to the current changes any variety of "form" he might wish, nor could he ever control and vary its intensity at will.

To find a patentable subject matter we must go beyond this. The interfering specifications do go beyond it. Each of them distinctly and expressly contemplates the presence of those special current variations which convey quality because their intensity and form is controlled and which have acquired the name of "undulatory" from the use of that word in Mr. Bell's speaking-telephone patent, partly to this interference. Each attributes to the receiving instrument (armature and magnet) the capacity to reproduce the quality or character of sounds when acted upon by such currents. Each describes it as combined with a circuit which includes a transmitter to be actuated by the sound waves of the air, shows that its peculiar qualities are given to it to enable it to enter into this combination, and declares that it is capable of reproducing to the character of these waves and thus producing a sound which will be similar to the sound vibrations at the transmitting station. Each of them also in fact shows the armature as constituting or forming part of a disk or diaphragm, closing the whole or part of the end of the tube or case on which it is mounted (p. 290).

Reading the issue so as to give force to all its words with reference to the patentable invention thus set forth in the specifications to which it relates (as it should be construed), we have no difficulty in ascertaining its meaning. It calls for an armature plate capable of reproducing the character or quality of sound under the influence of

the kind of current referred to, and without any limitation as to its construction (except that it must be fitted for this purpose); an electro-magnet for the same; a closed circuit passing thence to an actuating source; in that closed circuit a source of undulatory electric energy; that source is to be something which in its operation shall always keep closed the circuit which passes through it. This energy is to be "undulatory," as distinguished from broken or interrupted.

The mere enumeration or aggregation of these elements will not give a basis for a valid claim (p. 35). For that purpose they must be found in a true combination in which everything named I shall, by action upon or co-operation with the others, incite or modify their action, and either produce a unitary result when none would be produced without it, or materially modify such result as could be produced in their absence. One of the features expressly named is this "undulatory" character of the current. This element is not operative unless the combination or apparatus be such that the practical result which is produced when the current is of this character is different from that produced by a current of any other character. The element is not present for the purposes of a patent or to constitute an invention unless its presence be material to and makes itself felt in the character of the result.

The receiver, also, which is to be acted upon by the current, must have the capacity, when acted upon by that peculiar form of electric energy which is indicated by the word "undulatory," to produce a practical result, which will be reached when the current is "undulatory," and will not be reached if any other kind of current be employed. Therefore, it is only this special action of the one on the other which makes the "undulation" a proper element to be named in the claim.

There is but one kind of receiver and one kind of apparatus which will meet these conditions, and that is an apparatus which will transmit (in addition to or among other things) character or quality of sound. Each specification asserts this qualification for its instrument, and no apparatus having these qualifications had been described before the date of the first of these specifications. This agrees with the decision of the Commissioner, which was that this issue meant a

combination employed in precisising the art of transmitting articulation or quality, according to issue A (15 O. G. 777).

The instruments for the transmission of speech, shown in Mr. Bell's patent, meet these requirements. No one can prove a conception or a reduction to practice of the thing described in the issue unless he had in his mind a conception of an apparatus which would render *quality*, and had constructed and used an apparatus which practically did it. Now, none of the contestants had done this before Mr. Bell.

It is true that if Mr. Bell had made his first speaking telephone with a receiver which had neither magnet nor armature, another might afterwards have copied the apparatus as a whole from him, substituting the receiver of the issue, and would then have made the invention of this interference. But under the history of these parties a contestant who says that he made this receiver after Mr. Bell's invention of the telephone, states that he is the second to do it, because Mr. Bell invented it as part of his first telephone.

For a further discussion of these topics see pp. 93, 234-239, 267-270, 290, 293, 301, and 33-15, *supra*.

Dates.—Apart from the character of the work, none of the contestants can prove a date early enough to contend with Mr. Bell. Mr. Gray asserts that his wash-basin instrument meets the issue, but we have already shown that, considering the neglect to which he consigned it, and his rejection of it in his caveat, it must rank among incomplete or abandoned experiments.

Priority should therefore be awarded to Bell, the patentee.

Interference P.—The parties are: Bell, patent 174,465; Dolbear; Gray. The first count is for a magneto transmitter, and the second is for a magneto transmitter combined with a magneto receiver. Each of these contestants testifies that the magneto transmitter is entirely novel with Mr. Bell and that they learned it from him.

Priority should be awarded to Mr. Bell.

Interference G.—"A telephonic receiver, consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality [substantially Gray's claim]."

This is substantially described or shown in the applications of Dolbear, Edison and McDonough, and in patent of Bell."

The parties are the patentee Bell (174,465), Edison, Gray, Dolbear, McDonough. Gray's claim reads (vol. iii. p. 322), "the combination substantially as hereinafter set forth, in an electric circuit," etc. The declaration of interference informs us that the issue is "substantially" the same as the claim, and we are therefore to go to the claim and to the specification of which it forms part to find what it is that is "hereinafter set forth."

The language of the issue alone does not state an operative combination, because "the magnet" is not provided with a helix and no armature is mentioned. But by a familiar rule (*Forbush v. Cook*, 2 Fish. 668) we are to go to the specification to find what operation is intended, and then the law reads in the claim those parts which are described in the specification and necessary for that operation. The law does not dispense with the presence of these elements in the claim, but saves it by reading them there.

Indeed in Gray's specification the words "as hereinafter set forth" amount to an express statement that the armature and the magnet have the qualities which are shown in the specification and are necessary for the results described.

The issue, therefore, calls for a telephonic receiver which is to contain a magnet [and helix] and, supported and arranged in close proximity thereto, but not touching it, a diaphragm [which of itself is, or which carries, an armature]; the whole combined with an electric circuit upon which "sounds are thrown" [without regard to the character of the transmitting instrument, except that it must be such that by it "sounds are thrown upon the line"]. But while these must be included in the issue, they are not the whole of it. Its life is contained in the qualification found in its last two lines. All the parts are to be so constructed, arranged, and combined that by their operation "sounds thrown upon the line" [by any transmitter that will do it] shall be reproduced *accurately* as to pitch and *quality*. The express language of the issue excludes any instrument which is not so constructed as to do this.

The specification from which this claim is copied states that "the object of the invention is to provide an apparatus capable of accurately reproducing in an electric circuit, not only the different tones but the pitch and quality of sounds, whether produced by mechanism

or the vocal organs," and that "with an apparatus thus constructed vocal sounds or articulate words spoken in one instrument will be accurately reproduced in the other, both as to pitch and quality as well as tone."

"Quality" is here used, in its proper and technical sense, to include articulation, and Mr. Gray's application, if it ripened into a patent with this claim, would not be anticipated by an instrument which did not accurately reproduce spoken words.

The other parties also attribute to their described instrument the same qualifications. Mr. McDonough's application says that his instrument will reproduce articulate sounds, and calls it a "tele-phon," that is, a conveyer of words to a distance. (See it quoted on p. 222, and the others on p. 230.)

It is true that this issue is not in terms limited to a closed circuit. If anybody shall have constructed an instrument which will transmit conversation while employing a broken circuit, or a circuit-breaker transmitter, he could, so far as the law goes, maintain this claim. McDonough asserts that his circuit breaker will do this. He must not only assert this of his apparatus, but must prove it; and cannot be done, though McDonough does not appear to have known this when he filed his application.

It results therefore that no man can have constructed and practically operated an instrument, which, when he operated it, accurately reproduced the quality of all sounds thrown upon the line without discrimination, unless in the apparatus of which the receiver formed part he actually had sounds thrown upon the line in such a way that their quality could be reproduced, and an instrument to throw them there. (See pp. 18-15, *supra*, and pp. 222-306, *infra*.)

This receiver formed part of Bell's original conception of October, 1874, and of his subsequent apparatus, and no one anticipated him in such an apparatus as must be possessed for a reduction to practice of the invention of this issue.

Moreover, standing on a diaphragm receiver alone, whether fitted for this purpose or not, no contestant can show a conception di-

gently followed up by a successful reduction to practice which can antedate Mr. Bell in time.

It is probable that in declaring this interference the wrong one of Edison's applications was put into this issue. His 130 and 144 do show it. His 148 is the one in which the receiver is carefully prepared so as to extinguish all sounds except one. This feature renders it incapable of reproducing "sounds" generally, and especially incapable of reproducing quality, because it contains the contrivance invented by Helmholtz to destroy quality. This contrivance forms the subject of two out of his three claims, because it especially adapts it to fulfil the declared purposes of his invention, set forth in that specification which is for multiple telegraphy.

Priority should be awarded to the patentee, Bell. (See pp. 292-306.)

Interference I. — Issue 1 is for a magneto transmitter with metallic diaphragm. Dolbear is the only person besides Bell who attempted to make a magneto transmitter of any kind before the grant of Bell's second patent. Bell used one in May, 1876; he made an instrument expressly for the purpose July 1, 1876. He completed another set of finished instruments in October, 1876. Dolbear conceived of it in October or November, 1876, began to make his first instruments after Christmas, 1876, and had not finished or tried them when Bell's patent was granted.

Issue 2 involves the permanent magnet, and perhaps includes some details of construction. Mr. Bell conceived of it in October, 1874; declared in writing his intention of using it July 2, 1876; made it and used it in July, 1876; made another set of finished instruments in November, 1876. Mr. Dolbear conceived of it Sept. 20, 1876; began some rude models in October, but did not complete them; began an instrument after Christmas, 1876, and finished it just after Mr. Bell's patent was granted. The details of construction referred to were not in that instrument, and an instrument constructed a month or more later was the first one in which Dolbear used them, and there is no evidence of an earlier conception (pp. 306-312).

Priority on both issues is with the patentee, Bell.

Interference J. — This issue is on one of Mr. Edison's claims, and includes, as an element of the combination, a "resonant case." This

device is excellently adapted for the purpose for which Mr. Edison claims it in a harmonic multiple telegraph. It is inconsistent with the transmission of speech, which is the subject of the interfering applications and patent. The interference was improvidently declared (pp. 313-316).

Interference L.—This refers to some details of construction. The two issues, as they stand, are unintelligible or ambiguous, and include structures shown in the Yarley patent (Dowd case, vol. ii. p. 552), and in the well known Siemens polarized relay, used with the Siemens key (Dowd case, vol. i. p. 552, vol. ii. p. 607; *Interference Record*, vol. iii. pp. 385-6). Construed in the light of the specifications from which they are taken, they disclose inventions which are narrow, but giving to them any meaning which will include Mr. Bell's patent, he is entitled to priority (pp. 316-324).

BRIEF FOR FRANCIS BLAKE.

Interference No. 1.—“A spring forming or carrying one electrode of a telephone, and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movement of the diaphragm.”

This interference was declared Aug. 14, 1879, and the parties are Edison, Blake, Irwin, Voelker. It involves an improvement in articulating microphones. The characteristic of this class of instruments, and one chief purpose of the introduction of the spring, is that the contact between the electrodes shall never be broken, and the current shall never be interrupted. It is this which makes it a speaking telephone.

Mr. Edison's interfering application was filed July 20, 1877.

Mr. Blake took up the subject and invented in the summer of 1878, and in November, 1878, put upon the market, his “Blake transmitter,” which at once met with great success. After several thousand had gone into public use, Irwin's application was filed, May 24, 1879.

Irwin's story is that he first conceived of it in October, 1877. During the next three months he made one model—he thinks two—then three added the spring pressure in favor of a gravity contact, and made many instruments of that type and patented them. After

Blake's invention had become very successful, Irwin hunted up the remains of his old instruments and applied for a patent. He is a man of large means, and a professional experimenter and patentee, with a large experimental laboratory and machine shop. As against Edison he cannot contend on dates. As against Blake his early work must be held to be an experiment, abandoned, not followed up with such diligence as the case requires.

Voelker's Case.—After this interference had been declared, and Irwin had been officially informed of the date of Edison's application, which was earlier than his conception, he caused his employé, Voelker, to overhaul some old discarded models Voelker had in a trunk, and on them based an application filed by Voelker, Sept. 26, 1879, but owned by Irwin. Voelker attempts to carry his date back to May, 1875. The work and instruments he relies on are part of those already considered on pp. 9, 10, *supra*. The answer to them is that Voelker's work and his conceptions did not extend beyond a Re-é circuit-breaker, which he reinvented. He did not have the conception of the issue, viz., constant pressure to secure an unbroken contact. This was the conclusion Irwin and his advisers came to upon an examination of Voelker's work at the time. Moreover, whatever he the character of his work, it was not robust to practice; he did not succeed in transmitting a single sentence in a year of trial. He did not follow up the work with diligence. He resuscitated it only after Blake had succeeded, and his success had become famous.

Irwin knew all that Voelker had done. With this knowledge he swore in May, 1878, that he believed that he was the first inventor—his work began in October, 1877. It is not to be believed now that what Irwin, claiming as inventor, denied under oath, he can now, claiming as assignee, prove was then true, to his knowledge, to wit, that Voelker's work of 1876, on which Irwin built, made Voelker the first inventor.

A suit by Irwin against the Blake transmitter, decided in favor of Blake, Oct. 21, 1881, furnishes some instructive information.

Prof. Morion testifies (Interference Record, p. 278):—

"Cross-Int. 87. Please look at your sixty-seventh and sixty-eighth answers, particularly at the latter part of page 253, and tell me whether you find in the Gray battery transmitters, referred to in those answers, any contrivance by which that motion in the transmitter to which the variations in the current are due is produced by the sound waves which constitute or accompany words uttered by the human voice when in the presence of the transmitter.

"Ans. I do not.

"Cross-Int. 88. Please tell me whether in the same Gray instruments you find any contrivance by which the electrical variations produced in the circuit correspond in form or are similar in form to air vibrations produced by whatever words may be uttered in presence of the transmitter.

"Ans. I do not find any such action possible with any of Gray's transmitters or receivers, but only, as I before stated, in case two of his diaphragm receivers were connected in circuit with the battery."

Mr. Gray himself entirely agrees with this. In his speaking telephone caveat of Feb. 14, 1876 (p. 426), he says that it is impossible to transmit speech with an instrument which breaks the circuit. (See the passage quoted on p. 82, *supra*.)

Gray's *Cf. post.*—His caveat of July 14, 1876 (p. 425), shows that he had at best very vague ideas, and was so doubtful whether a liquid transmitter would work that he was not in a condition to prepare an application for a patent. His drawing is a diagram of a liquid transmitter and a membrane receiver; for he says that he contemplates the use of a series of diaphragms attached to a common vocalizing chamber, each responding to vibrations of a different rate—so far was he from believing that a single diaphragm would practically respond to the differing vibrations which correspond to the voice.

THE CASE OF THOMAS A. EDISON.

Edison's case is somewhat different from that of Bell's other competitors. At some time he did take up the subject of the speaking telephone; he devoted to it between one and two years of assiduous work; he alone of Mr. Bell's competitors produced and gave to commerce a practically serviceable instrument, the well-known soft

carbon transmitter, with which his name will always remain connected. But he took up the subject after he heard of Bell's exhibition at the Centennial. Bell created the art; Edison began as the inventor of improvements in apparatus with which to practise it. Whether he or Mr. Berliner was the first inventor of the true articulating microphone, is a question to be settled in another controversy; the improvements which are here the real subject of inquiry, in his behalf, are the spring-carried electrode (Issue No. 1, Edison, Blake, Irwin, Voelker), and the metallic diaphragm in a speaking telephone (Bell's second patent, Gray, Edison, Dolbear).

Certain absolute facts, and a printed publication, establish this as the extent of Edison's possible claims under the present interferences. Long known as an electrical inventor, he was possessed of an extensive experimental establishment, and was allowed by the Western Union Telegraph Company \$200 a week—say, \$10,000 a year—for more experimental expenses, in addition to which they paid for all his currents, applications for patents, etc. (See contract, vol. ii, p. 601; vol. i, bottom of p. 5; cross-ans. 150, p. 105).^{*} He availed himself of all these resources to the utmost, and during the three years covered by his testimony, and before the declaration of these interferences he filed forty-five applications and eleven caveats. None of these broadly claim a speaking telephone. All that relate to the transmission of speech are in terms for "improvements in speaking telegraphs."

It is obvious, and, indeed, well established, that such a claim, without a broader one, assumes and admits that "speaking telegraphs" had previously been invented by others. This is the mere conclusion here from the fact that the first paper filed which relates to the transmission of speech is his interfering application No. 130, April 27, 1877 (cross-ans. 170, p. 109), at which date the importance of the broad invention and Mr. Bell's claim thereto had long been publicly recognized. There is nothing in the case to show that Mr. Edison is in the habit of claiming all that he thinks he is entitled to.

One of his most important witnesses is Mr. E. H. Johnson, who has been for many years his trusted and confidential assistant, and

^{*} The evidence for Edison consists of vol. i. (790), which contains depositions, and vol. ii. (460), which contains his drawings, exhibits and applications.

who has been especially occupied upon Mr. Edison's telephonic work (Edison's case, vol. i, p. 283). It was from him that Edison, in July, 1876, first heard of Bell's Centennial Exhibition of June 26, 1876 (Edison, cross-ans. 303-302, pp. 114, 115).

Mr. Johnson, in 1879, while the commercial contest between the owners of the Edison inventions and the owners of the Bell inventions was very actively going on, wrote and printed a pamphlet, which has been put into the case by Edison, entitled, "Statement as to the Origin and Development of the Telephone." This pamphlet contains the following conclusive statement (Edison's case, vol. i, p. 295). Speaking first of Mr. Gray's telephonic work, Johnson's pamphlet says (the italics are ours):—

"As is above indicated, we find A. Graham Bell, of Boston, Mass., U. S., not only working upon the problem simultaneously with Gray, but anticipating him in the belief that its solution was practicable; and, as a natural consequence of the more persistent investigation, evolving, in absence of Gray and other competitors, the practical devices, thus becoming the true inventor of the apparatus for the transmission of speech. While Bell, however, was thus at work, another inventor, Thomas A. Edison, of Menlo Park, N. J., U. S. A., whose attention had been called to the subject of acoustic telegraphy by the Honorable William Orton, then president of the Western Union Telegraph Company, had already contributed largely to the solution of electrical acoustics, and taking up the subject of the transmission of articulate speech immediately after Bell's announcement of his achievement, and before he had yet made his device of the practical value, soon distanced even Bell himself in the brilliancy of his discoveries."

Here, then, we have a specific statement of Mr. Edison's principal witness and trusted assistant, the man who first communicated to him the invention of Bell which was announced to the world by its use at the Centennial Exhibition, that Mr. Edison did not take up the subject of the transmission of articulate speech until after that announcement had been made to him, to wit, five months after the issue of Bell's patent. The pamphlet of Johnson, written for the purpose of claiming for Edison, in England, as against the owners of Bell's English patent, all that the most enthusiastic admirer and partisan could claim for him, goes on and defines Edison's claim to be, that he is the inventor of that form of telephone which he says is the most powerful and useful, to wit, the soft carbon instrument,

What does
Bell's vol. 1
Telegraph
Imp. in Electric
Telephone

carbon transmitter, with which his name will always remain connected. But he took up the subject after he heard of Bell's exhibition at the Centennial. Bell created the art; Edison *began* as the inventor of improvements in apparatus with which to practise it. Whether he or Mr. Berliner was the first inventor of the true articulating microphone, is a question to be settled in another controversy; the improvements which are here the real subject of inquiry, in his behalf, are the spring-carried electrode (Issue No. 1, Edison, Blake, Irwin, Voelker), and the metallic diaphragm in a speaking telephone (Bell's second patent, Gray, Edison, Dolbear).

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^{*} The evidence for Edison consists of vol. I. (two), which contains depositions, and vol. II. (two), which contains his drawings, exhibits and applications.

who has been especially occupied upon Mr. Edison's telephone work (Edison's case, vol. I, p. 283). It was from him that Edison, in July, 1876, first heard of Bell's Centennial Exhibition of June 25, 1876 (Edison, cross-ans. 203-209, pp. 114, 115).

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What does
Bell wish for?
Telegraphs
Imp. in Electric
Telephony

but that Bell is the true inventor of the art, evolving in advance of all competitors the practical device.

Finally, as in none of his applications has he ever made the broad claim which is the subject of Interference A, so such a claim never was made for him until the Western Union Telegraph Company, in the fall of 1877, undertook their attack on Mr. Bell. For two years they had owned all Edison's electrical inventions, but then only for the first time did they set him up as the inventor of the telephone along with the other "first inventors" they then discovered.

Details of Edison's Evidence.—His content is with Bell's patent, 174,465, March 7, 1876, application Feb. 14, 1876, and Bell's patent 186,787, Jan. 30, 1877, application Jan. 15, 1877. Proof of invention after those dates has, of course, no bearing on the issue, though we shall refer to his history after those dates, because it is in some very important particulars absolutely inconsistent with the idea that he had accomplished, before Bell's patents, the things which Mr. Bell showed and claimed in them respectively. This remark is particularly necessary, because, in view of other controversies, Edison's proof was allowed to take a very wide range.

It may first be observed that the magneto transmitter (e. pp. 52, 176, *supra*) is not claimed or shown in any of Edison's applications; he, like Gray, expressly gives Bell the whole credit of this. His testifies (vol. c. p. 114):—

"Cross-Int. 200. When did you first hear of Mr. A. G. Bell?"

"Ans. I think it was about November or December, 1875."

"Cross-Int. 201. How did you first hear of him then?"

"Ans. Some one told me that such a man was working in the same line as Gray, on harmonic telegraphy."

"Cross-Int. 202. When did you first hear of his exhibition of his speaking telephone at the Centennial?"

"Ans. Some time in July, 1876. I think it was E. H. Johnson who first told me. From the description given me by Mr. Johnson,

that by talking against a diaphragm in front of a magnet to generate induction currents, I was led to believe what he said. I did not think it possible that induction currents could be generated sufficiently strong by this means to transmit, especially articulated speech. I want to say here, that I never conceived the possibility

of transmitting articulated speech by talking against the diaphragm

in front of an electro-magnet. I had never used my Exhibits A, A, for talking with, but only for receiving.

"Cross-Int. 203. Why did you not give Mr. Bell credit for that, in Mr. Prescott's book, at the same time when you said you had not invented that principle, if you then thought he was entitled to the credit of it?"

"Ans. I did most emphatically give Mr. Bell credit of the discovery of the transmission of articulated speech by that principle in this article, but it was scratched out by some person unknown to me, after it had been delivered to Mr. Prescott, and it was not published."

"Cross-Int. 204. Was Mr. Prescott, at the time that book was published, an officer of or employed by the Western Union Telegraph Company, or the Gold and Stock Telegraph Company, or the American Speaking Telephone Company?"

"Ans. He was employed I knew by the Western Union Telegraph Company, and he was, I think, a director in the American Speaking Telephone Company."

Edison's interfering applications are as follows:—

Application No. 130, filed April 27, 1877 (vol. ii. p. 1). This states the invention to be "an improvement in speaking telegraphs." It shows a transmitter in which the movement of a diaphragm, when spoken to, serves to vary the resistance of a circuit. The precise character of the means here employed to vary the resistance is not the subject of any inquiry in these interferences. The receiver shown is a magneto receiver, consisting of an electro-magnet and a diaphragm. It is stated that the diaphragms are preferably of sheet metal. The magnet is an ordinary electro-magnet, not permanently magnetized. This is put into cases A, B.

Application No. 141, filed July 20, 1877 (vol. ii. p. 15). This states the invention to be "an improvement in speaking telegraphs."

The transmitter shown is a true articulating microphone, with a contact point (as distinguished from a broad surface or soft pad of fluff, soft carbon, etc.) mounted on the end of an adjustable spring. The receiver is a monophone receiver. Certain other features are shown which are not here material. The substance of which the diaphragm is made is not stated; the materials of the microphone contact are platinum for one electrode, and compressed plumbago, mixed preferably with gum rubber, for the other, though it is stated that certain other semi-conductors may be employed instead of plumbago.

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This application appears in interference No. 1 on the spring-carried electrode.

Application No. 144, filed Sept. 5, 1877 (vol. ii. p. 20), states that the invention is "an improvement in speaking telegraphs." It shows a liquid transmitter of a rudimentary form, and a magneto receiver. It appears in C (liquid transmitter) and D (an adjusting screw in a liquid transmitter).

Application No. 145, filed Dec. 13, 1877 (vol. ii. p. 25), states the invention to be "an improvement in acoustic telegraphs." It shows a kind of magneto transmitter and receiver. It employs no diaphragm at all, but a vibrating metallic plate, or tongue, fastened at one end only to an independent support at some distance from the mouthpiece. It is stated that the mouthpiece may be of a shape which is adapted to select a particular tone and extinguish all others, like a Helmholtz resonator, or, it may be of an indifferent shape (shown as a cylinder about one and one quarter diameters long), if it is desired that it shall respond equally to all tones. The vibrating plate or tongue is polarized by attachment to a permanent magnet in order that it may respond to reversed currents. This is put into interference E, which purports to involve the use of any kind of metallic plate *armature*, and L, which purports to cover polarizing the armature reel or plate. We consider that this shows a harmonic or acoustic telegraph and not a speaking telephone.

Application No. 148, Dec. 24, 1877 (vol. ii. p. 29). The invention is stated to be—

"An improvement in acoustic telegraphs." "The object of this invention is to transmit several messages over one wire at the same time by employing acoustic vibrations or waves, passing over the line at different rates. The invention relates especially to the apparatus for reproducing such waves at the distant station and separating each series so as to render them audible only in that instrument with which they are in union."

The receiver has an iron diaphragm combined with a Helmholtz analyzing resonator, made of two telescopic tubes, for the purpose of tuning it to the note desired. It is obvious, not only that this is not a speaking telephone, but that the whole of it possesses, as proper for its purposes, those features which render the receivers absolutely unfit for speaking telephone receivers. This application has no proper

place in the speaking telephone interferences. It is made partly to G, which relates to a magneto receiver provided with a diaphragm of any material, arranged so as to reproduce all pitches and qualities of sound. It is also included in J, which relates to a magnet receiver, in which the diaphragm is of iron and the case is "resonant," whatever that may mean.

Much of Mr. Edison's work was expended on harmonic telegraphy. This, as is well known (e. p. 55, *supra*), has nothing to do with the transmission of speech. The transmitters are generally mechanical transmitters, each carefully contrived to produce a definite rate of electrical vibration. The receivers are tuned analyzers, each carefully prepared to respond only to its own rate. The one cannot produce those variations which constitute quality, and the other could not take note of them if they were produced. Nothing of this work, therefore, has any bearing on the subject. It will, however, be borne in mind that Mr. Bell had been engaged on this for many years, and had filed a number of applications on it before Edison began.

Edison's evidence is of two classes:—

1. Recollections of himself and his assistants.

2. Documentary Evidence.—He prepared many events and applications. He was in the habit of committing his thoughts to paper in the form of sketches, generally signed by himself and his laboratory assistants. Of these many thousands were made in the course of three years. Not all of the earlier part of that time are preserved, but most are, and all of these which have any bearing on the case appear in evidence. Four hundred and twenty-five sheets of them, containing not far from 1,500 sketches, have been put into the case and are photolithographed. These have not the value of working drawings by a man who never makes them till he has matured his ideas. They were made on blank books, distributed for this purpose about his laboratory (ans. p. p. 11), and are a record of his unaided notions as they arose, or notes of experiments as he or his assistants performed them; or, in large part, notes of ideas which never progressed as far as experiment; they do, however, define ideas and help to fix dates. His sketches of 1875 and 1876, as well as those of 1877, were on paper of uniform size, evidently provided for the

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purpose. They are subject to the criticism, so far as they state results, that they were prepared to be used as evidence, and, therefore, ambiguity or vagueness in them, or statements of results, ought to be received with some caution. On the other hand, it will be quite impossible to make any one believe that he had any ideas which he thought important unless these sketches show them.

The foregoing constitutes all his documentary evidence, with the exception of one piece of paper, a pencil sketch on the back of a translation of Legat's article on the Reis telephone. With the exception of that, none of his papers or sketches prior to the grant of Bell's first patent refer in any way to the transmission of speech, or exhibit any instruments which can be used as part of a speaking telephone apparatus. They are all confined to harmonic telegraphy. We shall presently examine them in detail, to show that this is their character.

His story which relates to the transmission of speech is as follows: In the summer of 1875, and the earliest date he "thinks was in July," or "about July," he was employed by the Western Union Telegraph Company to try and invent a system of harmonic telegraphy, in order that that company might obtain such a system without the expense of buying the one invented by Mr. Gray and Mr. Bell (Edison's case, vol. i, p. 4). In connection with this employment, and "in July, 1875," or "about July," Mr. Edison received from Mr. Orton, president of the Western Union, the translation of Legat's description of the Reis telephone (p. 6). This translation is printed in Edison's case (vol. ii, p. 509), Bell's case (vol. iii, p. 761). He knew perfectly well that a Reis telephone could not talk (vol. i, p. 10; p. 82, *supra*). On the back of this, and, he thinks, ten days after he received it, he made a few pencil marks, which indicate a very rude and mechanically impossible form of a liquid transmitter; but there is no pretence that such an instrument was made, or that an instrument made just as he there drew it would talk. He says himself (p. 9), "I have spoken as if these instruments were made. I do not mean to say they were made. My sketches were rough ideas of how to carry out that which was necessary, in my mind, to turn the Reis transmitter into an articulating transmitter; they were notes for future use in experimentation."

The preservation of these pencil memoranda was the result of accident. His regular sketches contained nothing on the subject until July, 1876, after he heard of Bell's exhibition at the Centennial.

In the fall of 1875 he made an instrument to measure currents; it had nothing to do with the transmission of speech (ans. 26, bottom of page 20). After this he made his first rude attempt to construct a liquid transmitter. His carelessness in answers is quite remarkable. His comment asked him when he first actually used instruments for the transmission of speech. A direct answer to that question would have been fatal to him, so he skillfully says, that an instrument was made for that purpose in December, 1875. He testifies (p. 21):—

"*Int. 27.* Please state in that connection about when it was that you did actually use instruments for the transmission of articulate speech.

"*Ans.* The first instrument made for the transmission of articulate speech was made some time in December, 1875.

"*Int. 28.* Please tell us what that was, and what you did with it.

"*Ans.* It consisted of a stretched membrane, with a point of wire fastened to its centre and immersed in electrolytic fluid, the wire electrode being adjusted so as to be immediately opposite another electrode, the two separated by a short column of water."

This is the whole of his answer, all he can say in reply to the inquiry "what he did with it."

"Some time in December" means the very end of December. He gives the date purely from memory, and so we cannot know. Mr. Bell's specification was sent to Washington before that.

This alleged instrument is not preserved. Of his only supposed experiment with this, Mr. Edison says (p. 22):—

"*Int. 31.* What was the result of the use of those transmitting and receiving instruments, which you have spoken of as made and used in November and December, 1875?

"*Ans.* The results were eminently unsatisfactory."

He says in his answer 33, that this was the only trial made with the voice in 1875.

We shall presently point out some circumstances which prove, with almost entire certainty, that no such instrument was made, and that Edison had in mind a structure made in 1877 (p. p. 198, *infra*).

But if his account were correct, it would not show enough to antedate Bell's patent. It shows a conception which, when embodied in an instrument, utterly failed to produce any result. Whereupon the subject was dropped, and not touched again until Mr. Bell's patent was six months old and had excited public attention. It was a fruitless experiment, abandoned. Nothing more was done by him about speaking telephones until July, 1876. His attention was devoted to harmonic telegraphy, and there is no evidence whatever that he even thought of the subject of transmitting speech. So that this is the utmost strength of his story before March 7, 1876, the date of Bell's patent.

June 25, 1876, Bell made his public Centennial exhibition of the actual transmission of speech. Mr. Edison was at once informed of this by E. H. Johnson, one of his assistants (cross-amt. 200-202, pp. 114, 115), and this first roused him into activity. What he did then of course does not affect Bell's patent, but is very significant to show that Edison had accomplished nothing, and knew he had accomplished nothing before. Johnson states (e. p. 189 *supra*) that it was after Bell's exhibition that Edison "took up the subject."

Of Edison's whole series of sketches, the first which, in any way, refers to the transmission of speech, is 3-10* (vol. ii, p. 40). This sketch was made July 6, 1876; another sketch (vol. ii, p. 447), probably of July 5, 1876, is a ruler-sketch of substantially the same character. They do not show a liquid transmitter in the sense of Interference C. A mass of wet paper or felt is pressed against a diaphragm, and the current passing through it is varied by the motion of the diaphragm. Mr. Edison testifies about it (p. 32). He does not appear to have himself devised, made, seen or used such an instrument. All his knowledge concerning it rests on the statements in the paper, in the handwriting of James Adams, who is dead, and Edison says that he cannot make out all the statements himself. Mr. Bachelor, another of Mr. Edison's principal assistants, says that his only knowledge is (p. 229), that he believes a series of experiments of this class was tried. Instrument like 25-10

* These sketches were in paper books numbered 9, 10, 11, etc., and the sheets in each have been numbered for the purposes of this case, thus 2-10 is sheet 2 of book 10. See table of contents of Edison's vol. 10, and pp. 201, 202, *infra*.

which Mr. Bachelor does remember, is simply for harmonic multiple telegraphy. Adams's memorandum is, "Get or good many words plain, such as 'How do you do?'"

The most important paper of the summer of 1876 is the document 101-10, 102-10, 103-10, 104-10 (vol. ii, p. 45). Edison employed Mr. Gilliland, one of his assistants, to experiment, and, August 2, 1876, Gilliland made a written report, which constitutes these sheets. Gilliland is not called, and, therefore, the paper is not competent evidence for Edison; it serves, however, to show the utmost his laboratory could produce. Edison says he thinks he started Gilliland on this "about May," but it is not at all likely that Gilliland worked three months without sketches or report, while Johnson's statement (p. 189, *supra*), contradicted by no one, shows that all these experiments began after July 1. This report contains the following passage (vol. ii, p. 47):—

"A plan, which, for want of perfect apparatus, was not thoroughly tested, is constructed on a very satisfactory plan, and will, undoubtedly, be a great improvement. A good model will be constructed, and a thorough test made at once. A platinum wire is attached to the diaphragm and immersed in a solution or liquid resistance; the strength of the wave is by this means varied according to the amplitude of the diaphragm. Various improvements and modifications of this plan are proposed. Such as shown for increasing amplitude, diamond shaped, immersing point of allumina."

Now an examination of the liquid transmitters described in the applications of Gray and Edison show that the construction is perfectly simple and no special device needed. This confusion that no speech had been yet transmitted with them in Edison's laboratory shows, not only the failure to construct a practical machine, but that no sufficient hope even was attached to the idea to induce them to take the pains to construct an instrument respectable in point of workmanship.

The date of the first liquid transmitter is now easily fixed.

Sketch 71-10 shows an instrument employing liquid, but no diaphragm, and does not come up to issue C. Edison testifies (bottom of page 33) that he made this sketch, which was dated July 29,

1876. That such an instrument was constructed, "but it did not work."

The next sketch which relates to the transmission of speech is 105-10, Oct. 12, 1876 (vol. II, p. 49; vol. I, pp. 43-115). This was made by Edison, and is a liquid transmitter of a very simple form, with a parchment diaphragm; it shows no receiver. There is no difficulty in recognizing it as the original rough sketch for the first articulating telephone of any kind which Edison produces, viz., Exhibit Water Telephone Instrument, of which a drawing is found vol. II, p. 518. Edison can only say that this was before November, 1876 (pp. 101, 129). Batchelor (p. 234) first saw it some time after the middle of December 1876, and thinks it had been made some time. Adams, now dead, made it. The dated sketch fixes it clearly in October, 1876.

It is evident, also, that Edison never attached any practical value to this invention. He made no application on it until his 144, Sept. 8, 1877, after the Western Union had commenced their attack on Mr. Bell, and obviously as part of it.

That is Edison's whole case on A, B, C, D.

We said that there is no adequate proof that Edison made any transmitting instrument whatever in 1875.

The only evidence whatever about it is Edison's own testimony, quoted on p. 195, *supra*. He gives the date as "some time in December, 1875," leaving nothing but memory to fix it by, and the date was five years before his deposition. When he comes to his water telephone, which was really of October 1876, he says (p. 101):—

"I have produced an instrument, marked 'Exhibit Water Telephone Instrument.' I can't state exactly when it was made; it might have been in December, 1875, or any month between that time and November, 1876."

It is obvious that so much confusion exists in his mind that his recollections cannot wait to prove any instrument of such a nature in December, 1875. Whether he made it in the fall of 1875 or in the fall of 1876 he cannot tell. But this is not all. Batchelor has been with Edison since 1870 (p. 223), and he remembers the instrument of October, 1876, but does not pretend to remember any in

1875, or any instrument intended for an articulating transmitter before July, 1876 (top of page 240).

Johs Krenesi (p. 263) is a workman long in Edison's employ, and who made experimental telephone models. He is the only workman called; he does not pretend to any articulating transmitter before the summer of 1876.

E. A. Johnson was with Edison then as a principal assistant and electrical engineer (pp. 283-285). He especially assisted Edison in his acoustic experiments in the fall of 1875. He does not pretend to speak of any such instrument. On the contrary, all the transmitters he remembers of that time were for harmonic multiple telegraphy, and were mechanical transmitters of a totally different character.

Prof. Robert Spivey, expert in acoustics and professor of natural philosophy, was with Edison to assist his experiments on sound almost every night from Nov. 22, 1875, to Jan. 29, 1876 (p. 299). He was precisely the man who would have seen such an instrument, and to whom Edison would have talked on the subject if he had had any serious hopes or intentions, and who would have appreciated and remembered it; but he has no knowledge about it, and says that all the transmitters he saw were "tuned forks and reeds" (ans. f, p. 299).

The *Imaginative Bell* (vol. I, p. 272; p. 220, *infra*) also assisted in these experiments, but he remembers nothing of them.

Mr. Edison (ans. 4, p. 9) says that his laboratory was "a kind of a public place," and he has never been reputed to be a man who concealed his achievements, but no one is produced who ever saw this alleged instrument.

It is certain, from Edison's express testimony, that if it existed it never transmitted a single word. The clear weight of his own evidence is that his imagination has carried back the instrument of October, 1876, and that nothing, that no instrument at all, existed in 1875.

It must, therefore, be taken (considering especially the burden of proof, and the presumptions arising from failure to apply till September, 1877) that Edison had in August, 1875, the vague ideas shown in his Reis translation sketch, but took no steps toward realizing them, even by the rudest experimental model, till July, 1876.

Mr. Edison's memory, as is naturally to be expected under the circumstances, is entirely untrustworthy about that early period, except so far as he has a dated sketch to aid him. He was asked (p. 31):—

"*Jan. 22.* You will please describe any telephone instrument made in 1876."

This led to a long answer on many subjects, which begins as follows:—

"*Jan.* In February or March, 1876, I took up the subject of transmitting articulate speech, using a transmitter which varied a volume of voice."

It is evident, in the first place, that, if that statement were true, it would not affect Mr. Bell's patent, the application for which was sworn to Jan. 20, 1876, filed in the Office Feb. 14, 1876. It is also evident from the remainder of Mr. Edison's answer on page 32, that he is entirely mistaken about the date, February or March; that he began to fix his date by a sketch, "Exhibit 3-10," which he said first was dated Jan. 6, 1876, and loaned his answer upon this mistake; but, upon looking at it again, he testified in the same answer that it was July and not Jan. 6.

Now that sketch is the first one produced to exhibit any instrument which it is pretended transmitted a single word. It is the first sketch of any telephone transmitter anywhere produced by him or anybody on his behalf, except the fragments of the nearly obliterated pencil drawing on the back of the Reis transmitter translation. It is the first sketch which, by its character and precision, gives any indication of any definite conception of an instrument, or of any intention to construct one, and no witness pretends to any sketch or transmitter before that. The sketch of July 6, 1876, was followed up by a number of others within a few days (see p. 33). And it certainly never was Mr. Edison's habit, with the thousands of sketches he made during the year, to start an idea and have only one sketch in six months to illustrate it by. It is quite clear, therefore, that his first models were in July, 1876, when, Johnson says, they began, after hearing of Bell's success.

Having now set forth Mr. Edison's story of all he did before Bell's second patent (186,787, Jan. 30, 1877, application Jan. 15, 1877),

so far as relates to anything shown in Bell's first patent, with all the general evidence, both oral and documentary, bearing on the same, we proceed to examine the details of his sketches, cavents and applications.

Those prior to Bell's first patent consist of sketches from Book No. 9, cavents 71, 73, 74, 75, sketch for cavent 75, applications 108-111, and the sketch on the back of the Reis translation.

From Book 9 he produces nine sketches:—

Sketch 6-9, Nov. 16, 1875, vol. ii. p. 31; referred to vol. i. pp. 14, 23, 226. Acoustic or harmonic telegraphy; analyzing tuning fork to close a circuit. The legend on it states that "the tuning fork responds only to vibrations in unison with its swinging time." This produces a jar, which operates to close a local circuit through a sounder, and thus serves as an analyzer and a relay. From such an instrument speech was neither intended nor possible.

Sketch 7-7, Nov. 1875, vol. ii. p. 32; referred to vol. i. pp. 11, 13, 23, 43, 226, 227. A magnetic relay. The core of an electro-magnet was a spiral spring forming part of a local circuit. When the main line current passed through the main coil, this spiral core became magnetic, the convolutions touched, and thus resistance was cut out. No sound waves employed; speech neither intended nor possible.

Sketch 8-0, Nov. 16, 1875, vol. ii. p. 33; vol. i. pp. 26, 27, 38, 226. An analyzing tuning fork in front of an electro-magnet acts as a relay, and opens and closes an electric circuit when the intermittent current in the electro-magnet vibrates it. The contact piece is mounted on a spring. Nothing to do with speech.

Sketches 8-0 (two sheets). Nov. 16, 1875, vol. ii. p. 34; vol. i. pp. 12, 13, 23, 25, 27, 43, 113, 226. Circuit-closing and analyzing relay, a combination of 6-9 and 7-0. Nothing to do with speech.

Sketch 10-0, Nov. 18, 1875, vol. ii. p. 36; vol. i. pp. 15, 23-25, 28, 48, 226-228. Acoustic telegraph with tuning fork circuit closer.

Sketch 11-0, Nov. 20, 1875, vol. ii. p. 37, not referred to by any witness. It is an acoustic telegraph; throws in and out electro-motive force by vibrating circuit breakers, each of which short-circuits its own battery or section, all the batteries being arranged in series. Nothing to do with speech.

Sketch 22-0, Nov. 21, 1875, vol. ii, p. 38; vol. i, pp. 15, 19, 26, 226. Acoustic telegraph receiver or relay. A tuned reed of steel worked by an electro-magnet opens and closes a circuit at each vibration. The contact points are carried on adjustable springs.

Sketch 22-9, Dec. 20, 1875, vol. ii, p. 39; vol. i, pp. 38, 226, 222. Harmonic analyzing receiver. It consists of a long tubular Helmholtz telescopic resonator of brass. One tube is five inches (three and one half diameters) long; the other, which slides in it, is six inches (four diameters) long. There is no diaphragm, but the outer one has one end *partly* closed by two strips of metal, which is not to be vibrated, while in front of it and in the open space between the metal strips is a reed, or, rather, in this imperfect sketch, a place for one. It is much like his instrument B (p. 516). It is the same as Fig. 14 of caveat 75 (after p. 576), and this is described in that caveat (filed Jan. 14, 1876) as an analyzing resonator with a steel spring vibrator (vol. ii, p. 571). Fig. 3 of caveat 74 shows the same kind of contrivance described as for the same purpose. This is the first of the drawings which shows an acoustic receiver of any kind for producing sounds to be heard. Nothing to do with speech.

The peculiarity of this type of instruments will be examined in connection with Exhibits A and B (pp. 208-212, *infra*).

Thus all the sketches before Bell's first patent relate to harmonic telegraphy solely. Not one of them has any bearing on the electrical transmission of speech, and the characteristic features of each are fatal to their use for that purpose.

Caveats 71, 73, 74, 75, vol. ii, pp. 546-568. Mr. Edison testifies (cross-ex. 171, p. 109) that none of these refer in terms to articulation speech. They show nothing intended or suited for that purpose.

Caveat No. 71, filed Dec. 2, 1875, is entitled "Acoustic Telegraph Apparatus." It says (p. 547), "The object of this invention is to transmit and receive several different messages over a single circuit at the same time, without interference with each other." It has seven figures. The transmitters are vibrating reed circuit breakers, placed generally in shunt circuits around sections of the battery; the contact points are carried on springs. The receivers are tuned reeds, whose motions close local circuits and work Morse sounders.

Caveat No. 73, filed Jan. 14, 1876, is entitled "Multiplex Telegraph." It begins (p. 555), "The object of this invention is to transmit several messages over a single wire at the same time, without interfering with each other." It contains ten figures. The transmitters are tuned reed circuit breakers with spring contacts, except one, which is a mechanical wheel circuit breaker. The receivers are tuned reed circuit breakers, with spring contacts, by which they open and close local circuits and work ordinary Morse sounders.

Caveat No. 74, filed Jan. 14, 1875, entitled "Improvement in Multiplex Telegraphs." It begins, "The object of this invention is to transmit several messages over a single circuit at the same time, without interference with each other." It contains twelve figures. All the transmitters are circuit breakers having definite rates. Some of the receivers are tuned reeds; in others the analyzing power is given by a column of air tuned to respond to a particular note and not to any other, the vibrating power being supplied by a reed. These air columns are obtained by the use of Helmholtz resonators, preferably arranged to be tuned at will by being constructed of sliding telescopic tubes. The specification particularly states (p. 525) that the object of this is that a vibration, whose period is the same as that of the analyzing resonator, will be heard "while all the other series of vibrations will be inaudible." The claims relating to receivers (claims 3, 5, 6) are based on this peculiar power of selection possessed by the instrument described.

None of these "resonators" are closed by diaphragms. Mr. Edison, in cross-ex. 176, p. 210, saw fit to apply the word "plate" to the vibrator of Fig. 4; the specification states that it is a spring reed in front of the analyzing resonator described in the above quotation.

Caveat No. 75 (p. 568), filed Jan. 14, 1876, has the same title and the same declared object as above quoted from No. 74. The statement of invention which relates to the receivers is as follows (p. 569):—

"The invention further consists in a method of analyzing several sets of vibrations received upon one or more electro-magnets, or

This is similar to the diaphragm to show in different forms, and is complete. See enclosure page 46. Many—giving the same.

came at 75 shows diaphragm

other similar devices, by the use of resonators, each of which has its column of air of such a length that it will only respond to a certain series of waves."

The instruments are in terms called "Helmholtz resonators." None of the resonators are closed by diaphragms; the air is all, except Fig. 12, is vibrated by reeds placed close to the front of the resonator without touching it. In Fig. 12 the reed is replaced by a strip of membrane, partly but not wholly covering the end vibrated by a sucking coil. This caveat has seventeen figures. It will be observed that before these were prepared, Mr. Edison had the aid of Prof. Spies, an expert in acoustic apparatus.

The original sketch for this caveat is made on Exhibit p. 577. The middle figure on the sheet is a resonator, also provided with a reed vibrated by an electro-magnet, at least this seems to be the meaning of it. If, however, this were a membrane and armature, it is very significant that it was *erased by Edison himself* (see nos. 49, p. 31; cross-ans. 132-134, p. 111), and does not appear in the caveat. It is, however, too late in date to affect Mr. Bell.

The character and function of a Helmholtz resonator, that it picks out one tone and kills the others, is well known. The instrument was invented by Helmholtz, in 1863, for the purpose of destroying articulation and enabling him to pick out any desired tone from a spoken word, and thus prove the theory stated on p. 46, *supra*. For further discussion of this point, see pp. 202-212, *infra*.

The principal features of these caveats were embodied in applications filed in 1876.

Edison's deposition (p. 108) gives a list of all his applications made after July 1, 1875; of these, numbers 103-113 were applied for before the date of Mr. Bell's first patent; none of them relate to the electrical production of sound. He testifies (p. 109) that no caveat and no application relating to the transmission of articulate speech was filed before the issue of Mr. Bell's second patent.

He made no publications on the subject before Mr. Bell's Centennial exhibition, but many in 1877-79.

His whole case, therefore, as against Mr. Bell's first patent, depends upon oral testimony of himself and his laboratory assistants, and this rude sketch. In weighing the value of his story, it must

be remembered that, during the eight months between his first attempt to produce sound by electricity (harmonic telegraphy) and Bell's first patent, he had abundant means to experiment, as the Western Union Telegraph Company furnished two hundred dollars a week for that purpose, say, \$15,000 a year (see contract, vol. ii. p. 601; cross-ans. 150, p. 105), and that during this time he filed ten applications and four caveats, the caveats embracing forty-six figures, and made a large number of sketches in his regular series of books.

Documentary Evidence for Edison subsequent to Bell's First Patent and before Bell's Second Patent.—The sketches are: The whole of Book 10, of which eleven sketches are put in evidence. The first is 8-10, dated July 6, 1876. Two of these eleven, to wit, 25-10, 73-10, relate to harmonic telegraphy solely, and show circuit breakers and tuned reed receivers. Four of them, 101-10, 102-10, 103-10, 104-10, are a single manuscript report by a person not called as a witness (Gilliland), relating to experiments made by him for Edison in Edison's laboratory. It is put in as part of Edison's work and to show his progress, and as such we accept it.

Sketch 3-10, July 6, 1876 (vol. ii. p. 40; vol. i. pp. 32, 129, 229), is the first of all his sketches which relates to a "talking telegraph." The transmitter has a mass of saturated paper arranged to be compressed by the vibrations of the diaphragm. The receiver is a tube, and the legend says it has an "iron armature pasted on to the parchment," i. e., a parchment and not a metal diaphragm. For results with it, see p. 194, *supra*.

Sketch 25-10, May 8, 1876 (vol. ii. p. 41; vol. i. pp. 35, 229), is entitled "Acoustic Telegraphy," and consists of two analyzing resonators, which are described by the legend as "resonant tube and membrane." The drawing and legend show that the membrane is moved by attachment to a tuned reed of a definite rate, the shorter resonator having the shorter reed. Edison (top of p. 33, vol. i.) says this was not for speech.

Sketch 58-10, July 26, 1876 (vol. ii. p. 42; vol. i. pp. 33, 120, 121, 229). It shows a multiple contact point transmitter; the legend says, "Got no results." This is the type of a series of experiments proceeding on a false theory of the vibration of mem-

branes and the nature of articulation, which Edison afterwards gave up as worthless. Edison testifies (p. 33) that he cannot remember whether this instrument was made or not.

Sketch 71-10, July 29, 1876 (vol. ii. p. 42; vol. i. p. 33). It was a total failure, and such an experiment was never repeated. See a description of it on pp. 197, 198, *supra*. It does not meet any issue.

Sketch 73-10, July 27, 1876 (vol. ii. p. 44; vol. i. pp. 35, 229). A multiple contact point instrument; that is, an instrument composed of a series of graduated circuit breakers. It is the culmination of the attempt to use circuit breakers. Of this Mr. Edison testifies (p. 35):—

"This was used for transmitting articulate speech, but it did not work. What I mean by saying that it did not work is, that it did not transmit articulate speech satisfactorily. That you could tell that some one was talking, and, if you knew what they were saying, it sounded awful like what they were saying."

This phrase very neatly expresses the substance of the strongest testimony produced on behalf of Voechler and McDonough.

Chapter vi. of Mr. Prescott's book "The Telephone," written by Edison himself, says of this class of attempts (p. 223, reprinted in Edison's Record, vol. ii. p. 674):—

"I endeavored to vary the resistance of the circuit proportionately with the amplitude of vibration of the diaphragm by the use of a multiplicity of platinum points, springs and resistive coils, — all of which were designed to be controlled by the movements of the diaphragm, but none of the devices were successful."

Papers 101-10, 102-10, 103-10, 104-10 are the Gilliland report of Aug. 2, 1876, referred to on p. 197, *supra*. It declares that the only diaphragms found practicable in receivers are made of membrane provided with iron armatures pasted on.

Sketch 105-10, Oct. 12, 1876 (vol. ii. p. 49; vol. i. pp. 43, 115), is a liquid transmitter, and is undoubtedly the original sketch for the first one Edison ever made (See for it p. 198, *supra*.)

Sketch 109-10, Aug. 10, 1876 (vol. ii. p. 50; vol. i. pp. 37, 229), multiple point instrument. Inherently worthless. Edison (p. 37) testifies that it was never constructed.

There are also some undated sketches which Mr. Edison says were made in 1876; they are:—

Sketch 79-15 (vol. ii. p. 443). This is a liquid transmitter, not dated. Edison's only testimony about this is, that it is a sketch of an instrument made "in 1876," and that "it did not operate satisfactorily" (p. 35). We already know what Edison means by "not satisfactorily," as defined in the same answer.

Sketches 80-15, 81-15, 83-15 (vol. ii. pp. 441-440). They are not dated. Edison testifies (vol. i. p. 44) that these sketches were made in March or April, 1876, or, in November or December, 1876. It is perfectly certain that the latter is at least as early as the true date (s. p. 198, *supra*). They show various devices for liquid transmitters, and for cutting in and out or short-circuiting films of phumbox, or other high resistance. Edison testifies (p. 44) that the corresponding instruments were made between March, 1876, and February, 1877, and that (p. 46) "our confidence was kept up by getting sentences now and then which were said to be pretty good." No one else testifies to them, and chapter vi. of Prescott's book, written by Edison himself (vol. i. p. 91), states that at this type of transmitter was given up as inherently bad and impracticable (vol. ii. p. 676).

Sketch 90-15 (vol. ii. p. 447). Date mostly torn off. Edison (vol. i. p. 33) thinks it was July 5, 1876. It is a liquid transmitter, the liquid being held either in a cup or in a mass of saturated paper. (See Bateholder, p. 230.) The sketch is signed by Adams alone; it does not appear whose idea it was; the instrument was unsuccessful. It is virtually the same as 3-10, s. p. 205, *supra*. Sketch 152-15 (vol. ii. p. 451), no date. Mr. Edison (vol. i. p. 40) thinks it was November, 1876. It is pretty obvious that this does not show a speaking telephone, but a circuit breaker, with a circuit breaker's spring contact. Mr. Edison (p. 40) does not know whether such an instrument was ever made.

During the period between Mr. Bell's two patents, Mr. Edison filed fourteen applications, viz., Nos. 114-127 (vol. i. p. 108). None of these relate in any way to the transmission of speech.

As the first of these sketches was after Mr. Bell's first patent and after Mr. Bell's exhibition at the Centennial, of which Edison heard at once (Edison, cross-ex. 202, p. 114), it is obvious that they con-

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200-1000
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not tend to antedate the broad invention of the art, nor of the liquid transmitter, or anything else contained in that patent. They could at most bear upon the question of priority relating to that improvement in a speaking telephone described and claimed in Bell's second patent, which consists in the use of a metallic diaphragm, secured at its edges, instead of a membrane diaphragm.

The Magneto Receiver with Metallic Diaphragm.

Mr. Edison is put in interference on some issues which involve the employment, for articulate speech, of a magneto receiver, consisting of an electro-magnet and a diaphragm of a circular form, supported at its edges, and which carries or constitutes an armature, free at its centre. He rests this entirely on two instruments, A and A', said to have been constructed in the late fall of 1875.

Many months before this Mr. Bell had conceived of the instrument, described it to Dr. Dike, constructed it for this purpose, used it, and prepared his specification. Obviously Mr. Edison cannot maintain a broad claim to such an apparatus as the membrane diaphragm magneto receiver, shown in Fig. 7 of Mr. Bell's first patent.

Mr. Edison, it is understood, however, claims that improvement in magneto transmitters which consists in the employment, for this purpose, of an true diaphragm in place of a membrane diaphragm and attached armature; this claim he rests on his instruments A and A'.

*Character of Edison's Exhibits A and A'.—*In the fall of 1875, Mr. Edison was engaged upon harmonic or acoustic telegraphy (see p. 24, *supra*). In this class of apparatus it is necessary that the receivers shall analyze the electric vibrations sent over the line, and each receiver respond audibly only to the rate for which it is tuned. From the time of the Varley patent (Dowd Record, vol. II, p. 550), in 1870, tuning forks or tuned reeds, or plates supported at one end like a reed, had been employed. Mr. Edison undertook to use another kind of analyzer. Helmholtz showed how thoroughly a body of air of a certain definite shape, given to it by the shape of the containing cavity and its openings, would respond to one pitch easily and to all others with great difficulty; he showed that the proper pitch would excite a violent and measured swing in the

contained air, while other pitches would waste themselves on it ineffectually. He also showed that, in practice, if aerial vibrations of several pitches came at once to such an instrument, it would greatly amplify those vibrations to which it was tuned and would greatly diminish all others. Here was an instrument, which, when exposed to the suitable sound alone, would much amplify it, and when exposed to many simultaneous vibrations would amplify one and much diminish all others. It was then an analyzer, and Helmholtz designed and used it for this purpose. Koenig's well-known monometric flame apparatus (shown in Deschanel's Nat. Phil. p. 357, § 678) is an analyzer consisting of a series of resonators closed with membrane or rubber diaphragms at one end.

Mr. Edison constructed harmonic telegraph analyzers or receivers on this principle. In some he amplified the effect of a tuned reed by a tuned resonator. In some he exposed one end of a tuned resonator to several simultaneous series of aerial vibrations, and relied on the resonator to give forth at the other end the rate of vibration or the sound desired. The air in the resonator sympathizes with the vibration proper to it, and is more moved by that rate of vibration than by any other; it is a case of sympathetic resonance.

In working out this branch, Mr. Edison called to his aid Prof. Robert Spies, an expert therein (Spies, *ans.* 4, *Edison's Record*, vol. I, p. 259; *cross-ex.* 22, p. 303), and, from Nov. 29, 1875, to Jan. 20, 1876, he was at Mr. Edison's laboratory almost every night. While he was there, or a few days before he went there, instruments A and A' were constructed; each consisted of a long tube of copper, about six inches or four diameters long, with a metal diaphragm at one end and an electro-magnet in front of it. The instruments were also provided with another tube, slightly smaller, which slid inside the larger one like the tubes of a telescope, so that the tube could, in practice, be adjusted to the desired length, that is, tuned. Such tubes are shown in Edison's application 140 (vol. II, p. 30). These were true resonators or analyzers.

Prof. Spies spoke of them as "plain tubes," and then testified (p. 304):—

"*Cross-Int.* 32. What do you mean by 'plain tubes,' in your 11th answer?

"Ans. By plain tubes I mean not telescopic, but having diaphragm and magnet at the end.

"Cross-Int. 33. Did these plain tubes act as Helmholtz resonators to re-enforce a particular sound, or did they equally re-enforce all sounds received?

"Ans. They acted as Helmholtz resonators.

"Cross-Int. 34. Was this result modified in any way by the cup and small tube spoken of in your 11th answer? If so, how?

"Ans. The cup and small tube decreased the loudness, but it was not an improvement."

It is proved, therefore, that the plain tubes were analyzing Helmholtz resonators, and that the addition of the second tube did not alter the character of the instrument, but introduced a change intended to improve it, though in fact of doubtful practical value.

Mr. Bateshor testified (p. 202) :—

"Cross-Int. 121. For the purpose of so increasing the volume of sound, did he apply any of the resonators indiscriminately to any fork, or did he apply to each fork the resonator of corresponding pitch?

"Ans. He could not apply any resonator to any fork to increase its sound, and did not do so except with the resonator that was suited for the pitch of that fork. In the particular instruments to which I refer each fork had its own resonator."

The control exercised by the column of air was not quite absolute, it is true. Prof. Splice says (p. 301) :—

"Int. 20. Referring to the instruments Exhibits A and A¹, have you any distinct recollection of these instruments, or any like them, being used at Mr. Edison's place, and if so, what kind of sound was produced by them?

"Ans. Yes, I remember them being used; the sounds were musical, and agreed mainly with the reeds or forks, but not always, on account of the instrumental appliances not being brought to perfection."

Still, though not absolutely perfect, they did analyze the vibrations sufficiently for Mr. Edison to use them. Mr. Edison testifies (p. 18) that three vibrating reed transmitters of different rates were arranged in one circuit with three such receivers :—

"These instruments were so constructed that the diaphragm of one was larger than the other; in other words, each instrument had a different sized diaphragm, the idea being that the small diaphragm would re-enforce the high, and the large diaphragm the low notes.

"These sound waves were broken up into definite intervals by a Morse key, so as to form dots and dashes, for the purpose of transmitting three different messages over the wire simultaneously by sound waves, rendered audible by these receivers."

Two of these three are A and A¹, which have diaphragms two and one fourth and two and one half inches in diameter respectively, and tubes nine and ten inches—say four diameters—long respectively. He testifies (p. 15, ans. 23) that there was a third with a still larger diaphragm, now destroyed. P. 103, he again states that all three were thus used in one circuit. P. 104, he says that these were the only diaphragm instruments made; that afterwards he employed tuned reeds instead of diaphragms. B (vol. ii. p. 510) is such a tuned reed instrument; this is the type shown in application 145. Exhibit 92-97 (vol. ii. p. 38) is the sketch for it; Edison (p. 19) says that it did not have a diaphragm.

In January, 1876, Mr. Edison began to file caveats, and followed these up by patents. All these showed resonators, generally of the form of the tubes A, A¹, though sometimes of the bulb shape also used by Helmholtz (n. p. 298, *supra*); see Figs. 14 and 17 of caveat 75, filed Jan. 14, 1876, and patent 198,087, applied for May 16, 1876; this patent shows bulbs, plain tubes and telescopic tubes, viz., *ES*, *L*, *S*, *U*, and *I*, and makes their employment as analyzers the subject of three claims.

Chapter iv. of Mr. Prescott's book on "The Telephone" was written by Edison himself, in the spring of 1878. These tubes were there described (p. 220; reprinted in Edison's Record vol. ii. p. 673). The text says of them :—

"The receivers R and R¹, Fig. 104, were formed of telescopic tubes of metal, by lengthening or shortening of which the column of air in either could be adjusted to vibrate in unison with the proper tone of the fork whose signals were to be received by each particular instrument. An iron diaphragm was soldered to one end of these tubes, and the latter placed in such a manner as to bring the diaphragms of each respectively just in front of an electro-magnet, which, in action, would cause them to vibrate. When the column of air in either receiver was properly adjusted in a given tone, the signals due to stopping and starting the vibrations by the distant key were very loud, as compared to other tones not in harmony with the column of air."

The Fig. 104 referred to in the foregoing extract shows two tele-scope tubes, which, when fully drawn out, were about four diameters long; this length he had obviously found practically effective to analyze.

It is certain, therefore, that the form of plain tube A and A' did practically operate to analyze.

Now it is clear, from the nature of articulate sounds, that such an instrument was worthless for whatsoever would understand what was said (e. pp. 56, *supra*). Indeed, Helmholtz invented them for the purpose of destroying the articulate character of sounds, and enabling him to pick out from the tones of the voice each tone present in it by amplifying that and nearly extinguishing the others. It is absurd to say, therefore, that one who merely experimented with such apparatus, had invented a receiver for articulate speech. The instrument Edison made possessed, as a whole, elements which were designed to give it qualities which unfitted it for that purpose, and one of those elements—the long tube—was so effective that he patented it at once as an analyzer. It is a bold proposition to make it also the basis for a chain for a receiver which will respond to all pitches and variations equally; and none the less bold from the fact that it is Bell's speaking telephone alone which has called for such an instrument or given it value.

Edison did indeed notice that the instruments A and A' did not analyze quite so perfectly as he desired, and if he had sought to make an instrument which would not analyze, and for that purpose had cut off the tubes, he would have invented a receiver which would have been useful for a speaking telephone receiver. But he did not make this instrument or this invention. There is no testimony whatever that he ever had this idea or sought to carry it out or thought to carry it out. On the contrary, instead of changing the character of the instrument, he abandoned it altogether; and when Mr. Bell had directed his attention to the speaking telephone, he declared that this receiver could not be used for this purpose. The proof is as follows:—

Remember that the employment of a diaphragm and magnet is not the subject of any serious inquiry, for in this Mr. Bell had, by conception and by actual production, preceded by many months Edison's

first attention to the subject of the electrical production of sound; all we have to concern ourselves with is the receiver for articulate speech, consisting of a magnet and a *metallic* diaphragm combined with elements which do not pick out special tones, and the whole so constructed that it will respond to delicate telephonic currents: It is the employment of an iron disk instead of parchment in an instrument for articulate speech, and as an *improvement*.

The proof shows that Edison employed metallic diaphragms in a class of instruments not adapted for telephonic currents or articulate speech, and that he determined that a metallic diaphragm was unfit for a speaking telephone.

In November, 1875, Edison had the long tubular instruments A and A'. In January, 1876, he prepared his caveat No. 75. His order or sketch for this shows on one sheet (vol. ii. p. 577) a magnet receiver (middle figure), which contains a diaphragm and magnet, but in this the *diaphragm is of membrane*; the drawing clearly shows the membrane patch glued on. Even this he thought worthless and obliterated it; it is not in his caveat now in any patent. His same caveat 75 shows in Fig. 12 a diaphragm receiver, which, however, does not answer the issue. Mr. Edison testified that this had a diaphragm. If so, it is very significant that the figure expressly mentions "membrane" as the material. It is, however, unfortunate, both for Edison's claim and for the general value of this testimony, that the caveat expressly says (vol. ii. p. 573) that this is not a diaphragm, but merely a "membranous strip" which closes one part of the end. This is all there is in his whole evidence relating to diaphragms of any kind before Mr. Bell's Centennial exhibition.

At that exhibition, communicated at once to Edison (e. p. 189, *supra*), Mr. Bell used a *metallic* diaphragm magnet receiver (e. pp. 28, 110, *supra*). If Edison had invented this, and actually possessed such instruments fit for this purpose, it should be expected that he would at once use them and claim them. What he did do is make certain by documents written at the time, and put into the case by him; and, *believe it is that he tried the instruments, discarded them as worthless, and determined and declared that the diaphragms must be of membrane.*

A & A' are admitted to have analyzed practically

His first sketch for a speaking telephone is in July, 1876 (v. p. 196, *supra*), and the statements, from that time forward, about the material for diaphragms in his receivers, are as follows:—

Sketch 3-10, July 6, 1876 (vol. ii. p. 40; vol. i. pp. 32, 129, 229). The legend is, "Iron armature pasted on to the *parchment*."

Sketch 25-10, May 8, 1876 (vol. ii. p. 41; vol. i. pp. 32, 229). This is for a harmonic or acoustic telegraph, and not for a speaking telephone, and shows two analyzing resonators. The legend is, "Resonant tubes and *membrane*," "one reed one note higher than the other"; and goes on to state how they are to be used for Morse signals.

Sketch 58-10, July 26, 1876 (vol. ii. p. 42; vol. i. pp. 33, 120, 121, 229). Material of diaphragm not shown or stated; instrument never made.

Sketch 71-10, July 29, 1876 (vol. ii. p. 43; vol. i. pp. 33, 34). Material of diaphragm not stated; Mr. Edison says that it did not work.

Sketch 73-10, July 27, 1876 (vol. ii. p. 44; vol. i. p. 4). Material of diaphragm not stated; Mr. Edison says that it did not work.

Next comes the very important report of Aug. 2, 1876, covering sheets 101-10, 102-10, 103-10, 104-10. It contains the following:—

"In our first experiments we found the parchment diaphragm in the transmitter could not be kept in adjustment, owing to the expansion and contraction from moisture of the breath; a thin brass diaphragm was substituted, which entirely overcame this difficulty, but otherwise gave no better results; a brass diaphragm in the receiving instrument is *inferior to parchment*, owing to a metallic ringing sound it gave."

It will be noticed that a brass diaphragm requires an iron armature as much as a membrane diaphragm does; it does not, therefore, answer Mr. Bell's patent, which shows for a material both metallic and magnetic.

Sketch 105-10, Oct. 12, 1876 (vol. ii. p. 49; vol. i. pp. 43, 115). This shows no receiver, but only a liquid transmitter; the legend states that the diaphragm is to be of parchment,—"parchment diaphragm." This is the sketch for the earliest transmitter produced; it is the "water telephone instrument," a drawing of which

is in vol. ii. p. 518. We have already shown the true date of this to be October or November, 1876. *It has a parchment diaphragm.* No one would have here employed a parchment diaphragm, exposed to the breath on one side and the vapor from a cup of water on the other, if he considered that metal was even capable of acting satisfactorily.

Sketches 80-15, 81-15, 83-15 (vol. ii. pp. 444-446), are not dated, but are said to have been made in November or December, 1876; sketch 80-15 has no legend, but the drawings show the banjo straining devices used with membranes; 81-15 has "blacklead or platinum on diaphragm membrane; the agitation of the membrane," etc.; sketch 83-15 shows in the drawing the stretching device and the rugged edges of a membrane.

Sketch 5-11, Jan. 20, 1877 (vol. ii. p. 51; vol. i. p. 46), does not expressly state the material, but also shows the same stretching device for its *membrane*.

Sketch 8-11, Feb. 9, 1877 (vol. ii. p. 53; vol. i. pp. 48, 129, 231), is the original sketch for the instrument of Edison's first application, 130. The legend expressly states that the diaphragm is to be of "*parchment*," and two of the sketches show the straining device used with parchment.

This was as far as Edison had got when Bell's patent of Jan. 30, 1877 (1876-78), came out. It is certain that Edison had not then *improved*, and did not know that he could *improve*, the instrument by employing a metallic diaphragm.

In the ordinary course of events Edison would receive Bell's patent about Feb. 15, 1876, and that would disclose to him that Bell had accomplished this improvement. *Then and there, for the first time, Edison thought that it might be desirable to employ what Bell had just patented.* So his sketch 15-11, of Feb. 19, 1877 (vol. ii. p. 57; vol. i. pp. 48, 231), expressly directs that the diaphragm be of metal. The legend reads, "In this case the disk is of metal," and one drawing has written upon it, "Metallic diaphragm." This clearly indicates the introduction of a feature so contrary to the previous practice of his laboratory that it needed to be twice mentioned.

Sketch 27-11, March 21, 1877 (vol. ii. p. 63; vol. i. p. 48),

metal
sketch of

all wrong

contains at its top a drawing marked "Patent Office Model, No. 1, \$10.00. Adhms." This is obviously the model for application No. 130, the instructions for which were given to Mr. Serrell, March 25, 1877 (vol. ii. p. 508; vol. i. pp. 47, 253). Sketch 25-11, of the same date, is a larger but ruler sketch of the same thing (vol. ii. p. 69; vol. i. pp. 101, 102). These sketches do not state in words the material of the diaphragm, but both of them show the banjo straining device commonly used with membranes. On pp. 129, 130, Mr. Edison testifies with regard to 8-11, that it had a parchment diaphragm, and adds, "This instrument was afterwards changed and embodied in case 150, metallic diaphragm being substituted."

Here, then, between February 9, and April 1, that is, after Mr. Bell's patent had been published, is the true date of the appearance of the metal diaphragm in this controversy on Mr. Edison's behalf. Up to that time every attempt to use it had failed, and he had discarded it in his sketches, in his experiments, and in every instrument he had constructed.

Mr. Bell patented it as an *improvement* over the membrane up to the time that patent was published. Edison having, he says, once tried metal in *some form*, discarded it, because, as he made and used it, he was satisfied that it was not equal to membrane. It cannot be said that he had invented and reduced to a practically operative and useful form, that improvement in speaking telephones which consists in making them with an iron diaphragm, as distinguished from membrane, nor that he had conceived of it for this purpose and was diligently reducing it to practice.

Some special details of Edison's Proof.—Mr. Edison's evidence refers to several matters which have no bearing on these interferences, but which should perhaps be noticed.

He has introduced in evidence his patent 141,777, Aug. 12, 1873, for a relay magnet, but it has nothing to do with any issue or invention involved in this case. It is an ordinary Morse sounder apparatus, worked with a local circuit and a transmitting key which works a relay also placed in a local circuit. The line circuit passes through two contact stops, one of which is carried on the lever of this relay. When this lever *f* is drawn down by closing the key *a*, the contact stop *l* carried on the lever touches

the screw *i*, and the line circuit is closed, and the battery *r*, with its full strength, works the Morse sounder *s* at the distant station. When the key *a* is raised, the retractile spring *e* of the transmitting relay draws back the lever *f*, separates the contact points *l* and *i* and opens the line circuit. So far there is nothing novel.

Mr. Edison enclosed these two contact points *l* and *i* in a cup which he filled with liquid. The effect of this was that the extremely high tension extra currents, which ordinarily make a spark and injure the contact points by burning them, were partly prevented and partly carried off through the liquid, and the spark thus avoided. This is the principle and practically the only purpose of the invention. The line current was so nearly destroyed by the separation of the points, that practically it operated on the distant instrument as if the circuit had been absolutely interrupted; in other words, the current varied from that due to the full strength of the battery when the points *l* and *i* make contact, and which energized the receiving magnet *s* enough to work the sounder, down to the excessively feeble and inaudible current which passes from the battery through the liquid when the point was separated, and which was totally insufficient to produce any effect whatever on the sounder. The apparatus then was, as a whole, one in which the receiving sounder *s* had its armature drawn to the magnet when the current surpassed a certain strength; while, when the current fell off below a certain point, the magnet no longer moved or controlled the armature, and its lever flew back to the back stop; and the transmitter was one which caused the current to pass from above a certain point to below another point in strength. The transmitter had no effect on the operation of the machine, except when it carried the current above the upper limit or below the lower limit; and the receiver did not operate at all unless the current was carried above the upper limit and below the lower limit. It was then an apparatus in which, as regards both the transmitter and the receiver, the operation depended upon the passing a certain upper limit and a certain lower limit. It noted whether the current did or did not pass these definite and fixed limits, but took no notice whatever of any other change.

It is obvious that such an apparatus does not, either in the transmitter or in the receiver, present the case of an instrument whose entire action depends upon taking advantage of every position of the electrodes in their whole range and not merely on their passage over a maximum limit or a minimum limit, or which depends for its results upon the capacity of the receiver to practically and mildly operate under every possible variation of current, whether it passes certain limits or not, and to give forth the character of sound due to its noticing every change inside of assigned limits. Indeed, it is not pretended for a moment that this patent of Edison's covers or shows or indicates or lends to the invention of the speaking telephone, or that it contains or sets forth any ideas, or exhibits in its operation any of the methods requisite for the transmission of speech. The most that can be said of its operation is, that it employs a cell of liquid to enclose the contact points and prevent a spark; but the employment of a cell of liquid even to vary the strength of the current by the movement of the contact points was old and perfectly known in the arts.

Mr. Bell's patent and the issue *C* do not more depend upon a rediscovery of that than they do upon a rediscovery of the electro-magnet used in the receiver. The invention rests in the construction of an apparatus for new purposes and with new capacities, and of course, is not the least anticipated by the fact that electro-magnets or wires or batteries or electrolytic cells have been used before.

Mr. Edison says that if he were to throw away his receiver shown in his patent, and throw away the primary circuit of the transmitter, and throw away the circuit-breaking key placed therein, and throw away the magnet and its armature and retain a cup of water and two wires, and then were to add to them the diaphragm of the transmitter and the sensitive receiver, and all those parts which go to make up a speaking telephone, and operate it by speaking to it instead of opening and closing a circuit with an ordinary Morse finger key, he would have a speaking telephone; which is undoubtedly true. And when he had done that he would have made a new invention.

It is obvious upon looking at the drawing of this patent, that even the motion of the transmitter lever *f d* is not controlled by the operator, so that the operator cannot in any way control the strength

of the current except to make it pass from a maximum to a minimum. When he depresses the key *a* he energizes the electro-magnet *c* and pulls the armature and its lever until its motion is arrested by *l* making contact with *i*; when he opens the key *a* the retractile spring *e* draws back the armature and its lever until its motion in that direction is arrested by the wire or point close to *e*, which makes the lock stop of the lever. The motion, therefore, in the transmitter, is a motion from one limit to another limit with no stoppage between the two, and is not a motion varying at every instant in speed, amplitude and direction which is given to the wire in a liquid transmitter, upon which infinite variations the whole operation of the speaking telephone depends.

Mr. Edison's other witnesses add nothing to his case. Scott, Bentley, Phelps, Plush, Murray and Prossett had nothing to do with the telephone until the summer of 1877, long after the grant of Bell's second patent.

Prof. Robert Spice was with Edison in December, 1875, and January, 1876, that is, almost up to the time of Bell's first patent, but he never had a word of conversation with Edison about the transmission of speech.

We have, however, two witnesses whose testimony on behalf of Mr. Edison goes a good deal further than anything Mr. Edison says himself.

Mr. Willbur, ex-examiner in the Patent Office, now counsel for Mr. Edison (with the nice distinction that he is counsel against Mr. Edison on telephone patents, but counsel for him in anything else), undertakes to intimate that at some time in 1875, he cannot tell when, Mr. Edison told him that an instrument in which one or two movable electrodes were caused to move in a liquid by being attached to a diaphragm which was spoken to, would make a talking telephone. Now, if this were true it would not amount to anything in law to overthrow Mr. Bell's patent; first, because it did not rise even to the dignity of a vague conception; and second, because Mr. Bell had already made his invention and reduced it to practice; and third, because it was not until October, 1876, more than a year afterwards, that Mr. Edison was able to make any instrument which would transmit speech. But Mr. Willbur, it appears from Mr. Bell's file

Wrapper and contents, was the principal examiner in the electrical room who passed on Mr. Bell's application for his patent on March 7, 1876; and it would be an intolerable scandal if the examiner who passed a patent to issue, could be allowed to come forward afterward and prove that that patent was invalid, by swearing that to *his knowledge* the same thing had been used in a legal sense or invented in any legal sense seven months before by a person who now employs him.

The other witness, equally extraordinary, called on behalf of Mr. Edison, is Josiah C. Reiff. Mr. Reiff appears to have been very intimately connected with Mr. Edison and to still have or to think that he has some (non-speaking) interest in his applications. (See his twenty-ninth cross-answer, p. 280.) He says that he is not an expert in any sense on the subject of this instrument (p. 280), which is undoubtedly true, and, under the circumstances, destroys any possible value his testimony might have. His testimony all accords with that of Mr. Edison's other witnesses, so far as he proves that the transmitters which Mr. Edison had in the latter part of 1875 were circuit-breaking instruments, forming a part of the harmonic or musical telegraph system which Mr. Edison was trying to invent; but he says (ans. 10, p. 275) that upon "one or more occasions" he thinks that he heard human voices, though he thinks that he has never even attempted to distinguish the words. Of course, no matter what his testimony is, or his credulity is, every one knows that that was simply impossible with the transmitters employed, and it is therefore amusing, rather than essential to our case, to trace his cross-examination. In his seventeenth cross-answer he says that he did not know whether the sound of the voices which he says he heard were transmitted electrically or not. Next, he says that the distances between the voices which he thinks he heard himself and the place where he listened was fifteen or sixteen feet, and that the persons were talking in lower tones than they would naturally talk in a quiet room, and were only separated from him by the distance and by a partition part wood and part glass (p. 278). Neither Mr. Edison, nor any one else connected with him, pretends that any such phenomena took place or by any possibility could have taken place. Mr. Reiff says that Mr. Robert Spice was there, not, like himself, from gen-

eral curiosity, but giving special attention to these experiments, and Mr. Spice, upon being called, does not pretend that any such thing took place.

Mr. Spice was an expert specially employed on these instruments almost every night for two months during that winter. He testifies (ans. 12, p. 300) that when he listened to the instruments he heard the sounds of the reeds or forks, but he does not suggest anything else. In his twentieth answer he says, being asked what kind of sounds were produced, that the sounds were musical and agreed mainly with the reeds or forks, but not always, on account of the instrumental appliances not being brought to perfection. In his twenty-third answer he was asked whether he ever heard through these instruments any other sounds than musical sounds. He says, yes, he heard the clicking of the keys; there is no pretence that he heard anything else. In his thirty-first cross-answer, he says that these reeds, the sound of which was all he heard, could not transmit anything except their own pitch, and he explains this very well indeed in his twenty-eighth re-direct answer (p. 305): "The sound transmitted by a vibrating reed circuit breaker will be the musical pitch of the reed; but if other sounds are present and act to any appreciable extent at all on the reed, *they do not act to change its pitch, or to change the character of the sound which it produces, but to diminish the loudness of the sound.*" Again, he expressly says, with reference to any possible conceivable action of the human voice on such a transmitter, that the only effect he can conceive of would be that a very loud sound made very near the reed might diminish the loudness of the sound produced by the reed, but that he never heard that even such a change was ever produced. He never heard any one say that it was possible to produce such a change, that it would be possible for any such apparatus to distinguish the voice of the speaker; this is fully and carefully stated by him on the 307th page.

It is worth comparing the testimony of an ignorant and interested man like Mr. Reiff—ignorant, we mean, as to the class of apparatus, for he evidently is a man of good business capacity and ordinary intelligence and education,—with the testimony to the same experiments and the same phenomena of an intelligent expert like Mr. Spice, whose mind was carefully directed to noting exactly what took place;

for we shall have constant occasion throughout all these interferences to say, that where the skilled man, the careful observer, with the utmost attention, found nothing, the unskilled or the careless or the interested are ready, probably with entire satisfaction to their own consciences, after five or six or seven years' lapse of time, to fancy that they heard even the same sounds that everybody has become so familiar with since Mr. Bell produced the speaking telephone.

CASE OF JAMES W. McDONOUGH.

Mr. McDonough is of those who never know how to transmit articulate speech, but who, since the grant of Mr. Bell's patent, have sought to acquire the profits due to Mr. Bell's invention. This particular claimant has not even any pretensions to the invention of a speaking telephone; he merely reinvented the Reis transmitter, and this is so adjudged; his way of laying hold of Mr. Bell's invention is to present a chain to the receiver which Mr. Bell invented as part of his apparatus. Upon examination it will be found:—

1. That Mr. McDonough did not invent or construct a speaking telephone.
2. That his apparatus as a whole was a failure; and, therefore, he cannot dissociate a part from the rest to control one who has already patented that feature as part of a complete and useful whole.
3. That in his dates (whatever be the character of his work) he is subsequent to Mr. Bell.

His application says (p. 471):—

"The object of my invention is to provide a means for transmitting articulate sounds from one place to another through the medium of electricity, and it consists in the combination with an electrical battery, circuit wires, armature, magnet and *circuit breaker*, of a transmitting and receiving membrane, a sounding apparatus so constructed as to vibrate in accord with the vibrations of articulate sound, and so arranged, relative to the magnet and circuit breaker, that the vibrations of the transmitting membrane or apparatus, produced by articulate sounds, are transmitted by the electrical current to the receiving membrane or apparatus, and so as to cause a like vibration of the receiving membrane or apparatus, and cause it to reproduce the articulate sounds transmitted from and by the transmitting membrane or apparatus. My invention also consists in the novel construction of the *circuit breaker*, as is hereinafter more fully described."

THE INTERFERENCE ISSUES.

We now proceed to consider each issue by itself, and to state in connection with it the facts particularly relating thereto.

These interferences were declared very loosely and very carelessly. When they were before the Commissioner on a former occasion he said that he could see no patentable difference between some of them, but thought it best that they should go on, in order that a decision might be made as the facts should be developed bearing on the controversy which clearly existed between the parties and were substantially indicated by the issues. Perhaps, with the knowledge which existed in the examiner's room in March, 1878, they were as well declared as could be expected. The parties have taken this view, have introduced their evidence fully, and the issues should be treated and decided accordingly without the reformation which they might receive to-day; for some of the parties have been waiting five years, and it would not be creditable to the Office to prolong the controversy.

Interferences A to G involve Mr. Bell's first patent, 174,465. That patent had been granted, its results had been publicly made known, and Mr. Bell had been famous for more than a year as the first inventor of a new thing of wonderful character before his present competitors (with one exception on one issue) appeared to the public as claimants. Their pretensions were first announced, their alleged efforts made known, and their claim to the honor preferred only when the invention had become a practical success and promised great and assured profits. They first appeared after the victory.

Interference A is as follows:—

"The hereinbefore described art of transmitting and reproducing at a distance sonorous waves or vibrations of any description, which consists in increasing and decreasing the strength of an electric current traversing a circuit in such a manner as to produce in said circuit a series of electrical waves or vibrations, precisely corresponding, in their intervals of succession and relative amplitudes, to the sonorous waves which are to be reproduced at the receiving station or stations, so that oral conversations or sounds of any description may be telegraphically transmitted."

The parties are:—

Bell, patent 174,465, March 7, 1876.

Edison, application 120, April 27, 1877.

Gray, application No. 1, Oct. 20, 1877.

Dulhear, application Oct. 31, 1877.

Voelker, application May 19, 1877.

The issue is in the language of Gray's first claim. It is also, in the opinion of the Office and correctly, substantially the method specified in Bell's fifth claim. That fifth claim is as follows:—

"The method of, and apparatus for, transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

None of the applicants, except those just named, make any claim whatever to this method, or to any method. The claims of the others are merely to details of the apparatus employed in carrying it out.

The gist of the invention intended to be covered by this issue is, that the sound vibrations produced in the air by the voice of the speaker shall, of themselves, operate to cause electrical variations or undulations on the line, which, in their *form*, in the technical sense of that word, are similar to the form of the air vibrations; and that these electrical undulations, having this special character, shall, by an appropriate instrument at the farther end of the line, be there converted into vocal undulations or vibrations of the same character or form. It will be observed in this apparatus, and in any apparatus practising this method, indeed in the method itself, that the fluctuations in the current are due, not to artificial mechanism, but to sound waves themselves in the air. Next, that the fluctuations in the current are similar to the sound waves which caused them,—unbroken in their continuity, specially modified in their form; finally, that the fluctuations in the current are, so to speak, reconverted into sound waves at the receiving station by the appropriate instrument (*v. pp. 58, 49, 50, supra*).

One essential feature of this art, to wit, that it shall be the voice which actuates the transmitter, is not very clearly stated in the issue, except by the last clause: "so that *oral* communications or sounds of

any description may be telegraphically transmitted." That, perhaps, is sufficient, because it implies by the phrase "transmission of conversation," not that a noise is to be produced at a distant station, but that the conversation of the speaker itself is to be transmitted, and is to be the cause of the sound (*v. pp. 58, 51, 50, supra*). This has been established as the meaning of this issue by Commissioner Paine, who says of it (*Gray v. Bell*, 15 O. G. 778):—

"The first inventor who discovered that nature had made electricity a vehicle for the transmission of the quality as well as the pitch and strength of the human voice, and first devised a practical method for the variation of an electric current in a circuit by means of the sound vibrations caused by articulate speech, and of reproducing the delivering at that point the same words, with their strength, pitch and quality unchanged, and devised means for carrying out this method, is entitled to protection as against all subsequent inventors, both for his method and for his particular means."

This is the meaning which he attributes to issue A, and it is because he attributes that meaning to it that he considers it constitutes a proper issue of patentable subject matter.

We are to inquire then who, in the sense of the law, first invented an apparatus in which the numerous vibrations in the air due to spoken words, or to any other sound, of themselves operated the instrument and caused undulations in the current of similar form, which undulations reproduced the same sound vibrations at a remote point of the circuit, so perfectly that the ear there took note of these reproduced sound vibrations as signifying the same words that were uttered by the speaker at the transmitting station.

Dates of the Parties.

Mr. BELL definitely and precisely conceived of this method, and of an apparatus for carrying it out, at least as early as October, 1874, and then disclosed it to Dr. Chersons J. Hinkle, a gentleman who was perfectly competent to understand it and appreciate it (*pp. 64, supra*). Mr. Bell devoted himself with great assiduity to thinking out instrumentalities which would overcome what he conceived to be the practical difficulties connected with that apparatus, and talked with others about it, that is to say, he was trying to reduce

it to practice (pp. 64-72, *supra*). In June, 1875, he made an apparatus which was exactly the same as that of his patent and of his previous conception; and, although, from accidental circumstances, the results then obtained were not perfectly good, he was conscious that he had constructed an operative instrument, and that if it lacked anything, it merely lacked mechanical perfection without variation in its design or in its mode of operation; and with a great deal of energy and perseverance he pushed on until he had obtained his patent; thus showing that he believed that the problem was solved forever, although, no doubt, he was conscious that the instrument could be further improved (pp. 69-73, *supra*). In October, 1875, he began to prepare his specification. During all the intervening period his work was as sedulous as his circumstances, pecuniary and otherwise, would permit: he labored nights and days; his exertions resulted in success; while his letters, written at the time, show that his mind was continually intent on the subject (pp. 66, 67, *supra*). His date of invention for this issue, therefore, was October, 1874.

Mr. Edison's story briefly is, that about August, 1875, he conceived some ideas relating to the transmission of speech, and made a rude pencil sketch on the back of a paper he was using, simply as "rough ideas, notes for future use in experimentation." He, in one part of his testimony, seems to think that in November, 1875, he attempted to construct an instrument, not like his sketch exactly, but of the same general character so far as the transmitter is concerned, though he obtained no results whatever with it, and never had it again or preserved it. The evidence, however, shows that he had mixed up the fall of 1875 with the fall of 1876, and that he never attempted to construct a speaking telephone, or got beyond his mere pencil memorandum, until July, 1876, after he had heard of Bell's successful transmission of speech in the presence of the judges and a large number of persons at the Centennial Exhibition (pp. 129, 139, *supra*). Mr. Edison's invention, therefore, really dates from July, 1876, because, even if he had done all that he claimed in 1875, he certainly did not then reduce it to practice, and between the fall of 1875 and his knowledge of Bell's success, in the summer of 1876, he did absolutely nothing. He did not exer-

cise the "reasonable diligence" of the statute which would enable him to date back to 1875. Moreover, there is no reason to think that Mr. Edison had the idea for a moment that he was the first inventor of what was first described in this issue. He never claimed it. The application is for an "improvement in speaking telephones" or *sonnettes*, and it is difficult to see upon what pretence the Office puts an application for an improvement in speaking telephones into interference with a patent more than a year old, which for the first time showed a speaking telephone of any kind, but which did not show specifically the forms exhibited in the later application.

Finally, Mr. Edison puts in evidence a publication made on his behalf by his assistant and witness Johnson in 1879, which states in terms that Bell is "the true inventor of the apparatus for the transmission of speech," and that Edison "took up the subject of the transmission of articulate speech immediately after Bell's announcement of his achievement" (p. 189, *supra*).

GRAY'S CASE.—Mr. Gray conceived some ideas on the subject at a date which was not before the time when the "lovers' telegraph" was explained to him and shown to him in December, 1875, and not after Feb. 11, 1876 (p. 171, *supra*). There is no evidence tending to show that he had any definite ideas whatever about it, or disclosed any ideas to anybody until Feb. 11, 1876, when he made a sketch and caveat, which was prepared, sworn to and filed on the 14th of February, a few hours after Mr. Bell's application filed on the same day (p. 171, *supra*). Mr. Bell's application was signed and sworn to on the 29th of January, and that antedate Mr. Gray's conceptions. The grant of Mr. Bell's patent and the public exhibition of Bell's apparatus and its actual use by Mr. Gray antedate Gray's first attempt to reduce to practice. It appears that Mr. Gray never attempted to construct an instrument until after he had seen Bell's patent and had personally used Mr. Bell's telephone and heard speech transmitted through it at the Centennial; that the instrument he then endeavored to construct was not like Bell's, but was of a different character, and that he had given him no results whatever, and it does not appear that he had ever transmitted a single articulate word, or that he had any instrument for that purpose which now exists, or which is supposed or alleged to have been capable of transmitting a word until Mr. Bell's patent was one year old (p. 172, *supra*). Finally, Mr. Gray very properly, in the spring of 1877, distinctly and unequivocally, in

private letters and in public lectures when Mr. Bell was present, declared and acknowledged that Mr. Bell was the first inventor of the speaking telephone (p. 173, *supra*). Even if Mr. Gray's conceptions had been earlier than they were, this state of facts shows that he exercised no diligence whatever in perfecting them, or adapting them to practice. Lastly, he did not make his appearance in the Office until Mr. Bell had many thousand instruments in commercial use, and then he appeared as assignor to the Western Union Telegraph Company, who had announced their intention of obtaining possession of this invention by some means (pp. 34, 35, *supra*).

Mr. Gray's application should, as a matter of law, state his invention and the best mode in which he has contemplated applying it (R. S. 4,888). He has, in fact, in his application in which he claims broadly this method, described, as a means for applying it or a mode for applying it, an apparatus to the invention of which, on the one hand, he confesses that he has no claim whatever, to wit, the magnet transmission apparatus. He has set forth in his specification, as the direction which he gives to the public for the practice of his invention, information which did not originate with him, but which he has learned from the invention and patent of Mr. Bell, whom he seeks to supplant (pp. 183, 184, *supra*). Now, apart from the question whether a patent granted on such an application would be valid, it is certain that Mr. Gray has stated in that application as part of the information which, in his opinion, should be laid before the public, in order to enable them to practice it, matters which he did not know at the time he made his alleged invention, and which he has solely learned from the published patent and instruments of his rival. We have already stated the inference which the Office and law should draw from that course of conduct.

We must call attention to one part of Mr. Gray's deposition which might mislead, unless carefully read. The issue is in the language of Mr. Gray's principal claim, so that he cannot complain that it does not correctly describe the real subject matter of the controversy he sought to raise. In Int. 8 to him (vol. iii. p. 337), by using the language of part of the issue, and omitting the remaining and most valuable part of it, an inquiry is framed to which Mr. Gray can give an early date. But nothing can bring out the fact better than this interrogation, which shows that in 1874 Mr. Gray did something

which did not meet the issue as he himself has stated it; while his Ans. 12, p. 391, states that his first attempt to construct an apparatus which could embody the invention was in July, 1876, when he had known for three months of Bell's patent, and seen his apparatus.

DOLBEAR'S CASE. — Mr. Dolbear's explicit testimony is, that Mr. Bell, and not himself, is the first inventor of the speaking telephone (pp. 161-164, *supra*); that he had no ideas on the subject until after he had heard of Mr. Bell's success at the Centennial; and in his application, filed when Bell's patent was eighteen months old, he made no claim whatever to the matter of Interference A. Moreover, he, in private letters and in printed publications in 1877, declared that Mr. Bell was the first inventor of the speaking telephone (p. 165, *supra*).

VOLTEKKE'S CASE. — There are two answers to Voltekker's case: one is, that in his dates he is subsequent to Bell; and another is, that although his application contains descriptive matter sufficient to give rise to this issue, yet his invention, if it can be called invention, was not what was disclosed in his specification, but was something of an entirely different character. As to his dates, the testimony is that his first attention to the subject was "during the month of January, 1876," but in what part of that month is not stated, and that the first instrument, whether operative or not, was constructed in the early part of March, 1876 (pp. 117-121 and 129, *supra*). Upon referring to Mr. Bell's dates it will be seen that his application was signed and sworn to Jan. 20, which of itself carries Mr. Bell's first conception back of Voltekker's, while the proof shows that Mr. Bell's patent was not only applied for, but actually granted, before Voltekker commenced the construction of any instrument whatever.

Character of Voltekker's Instruments. — They were not speaking telephones. They did not produce in the circuit electric waves or vibrations, which in their *amplitudes*, as well as their intervals of succession, corresponded to the numerous waves of articulate speech as defined in the issue. His instruments were circuit breakers or Reiss transmitters. They were not speaking telephones, and he had not made the invention set forth in Interference A, because he never conceived of the necessity or of the possibility of giving to the electric current the character set forth in the issue, first disclosed by Mr.

Bell's patent, and now known to be, so far as our present knowledge goes, essential to the transmission of speech; and he had not, by his instrument, given that form to the current in the circuit. This is shown by the explicit statement in his deposition (quoted p. 129, *supra*) that his conception was to break the circuit at each vibration of the diaphragm, as a Morse key breaks it, and that this was the idea embodied in his instruments when he constructed them; there is no statement by him to others at the time nor in his deposition that he ever changed that conception, or sought to embody any other; the express proof is that what he had done was to reinvent the Bell's transmitter; all his results are consistent with the use of that kind of apparatus and inconsistent with any other (pp. 126-137, *supra*). Finally, whatever his conception may have been, or whatever his date of conception might have been, he nowhere showed the diligence which the law required. From the beginning of 1876, when he says his conception originated, down to the fall of 1877, he made no progress whatever, and from December, 1877, to the latter part of May, 1879, when he applied for his patent, he did nothing at all on the subject (p. 137, *supra*). His instruments slumbered in a trunk and were brought out only to support Mr. Iwitt's scheme in 1879 (see quoted p. , *supra*). Moreover, when he applied for his patent he did not pretend to be the inventor of the art, but only of certain improvements in the apparatus, and the amendments which put him into this interference were made December, 1879.

It is true, he testifies that he "made this invention" at a date named, but that is not competent evidence; it is a mixed conclusion of law and fact which the tribunal is to determine, and the witness's assertion is of no value on it.

Stevens v. Putnam, 18 O. G. 520 (p. 242, *supra*).

Shale v. Dhir, 17 O. G. 261 (p. 243, *supra*).

Ex parte Gasser, 17 O. G. 507 (p. 246, *supra*).

Before he filed his first application, Mr. Bell's speaking telephones had been in use for more than two years, and that, of itself, is a sufficient bar to Volcker's application (pp. 118, 141, *supra*).

The most satisfactory answer, however, is that he did not invent a speaking telephone.

Priority on this issue must therefore be decided in favor of Mr. Bell, the patentee.

INTERFERENCE B.

This interference is as follows:—

"The heretofore-described improvement in the art of transmitting vocal sounds, or spoken words, telegraphically, which consists in throwing upon the line, through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air produced by a spoken word."

The parties to this interference are:—

Bell, patent 174,465, March 7, 1876.

Edison, application 180, April 27, 1877.

Gray, application No. 1, October 29, 1877.

Volcker, application, May 19, 1879.

Interference A, already considered, covers the use of any form of electrical apparatus in which the transmitter takes up from the sound waves which constitute spoken words, their peculiar character of motion, and employs that motion in the transmitter, by any kind of electrical contrivance, to produce electrical vibrations corresponding in form to the motion, and, finally, at the receiving station, recovers these electrical vibrations into corresponding motions of some material substance which correspondingly moves the air, and thereby produces, at the receiving station, a sound which, not merely in pitch, but in articulate quality, is recognizably the same as that which operates the instrument at the transmitting station; so that the oral speech uttered into one instrument is heard to proceed from the other.

We have already explained (p. 53, *supra*) that there are two ways in which the motion can be employed to vary the strength of a current: one is, by changing the electro-motive force or energy brought into a circuit whose resistance remains unchanged; the other is, by varying the electrical resistance of the circuit which is supplied at all times with a constant amount of electrical energy.

Interference A covers the use of an apparatus which employs one of these modes to convert the motion in the transmitter into electrical variations, and equally includes an apparatus which employs the other

mole of conversion for the same purpose; but still there are patentable differences between the two types of apparatus, and it may well happen that after one person has invented and patented one, another may produce another instrument for practicing the same method or art, which, while it comes under the earlier patent, would yet be in the nature of a patentable alteration or improvement. It is true that a patent for the first issue, that is, the art or method broadly stated, must describe and must include one of those types of instrument, because, unless it does, it does not show any way of practicing it. Yet the patent would be sustained as a broad patent if it showed only one way, while the second person, who afterwards invented another transmitting instrument, which, in the apparatus as a whole, would take the place of the first transmitting instrument, might have a subordinate patent as for a subcombination in the nature of an improvement on the first. It would not be a patent for an instrument or entire apparatus which would displace that of the first patentee. It would be a patent for one component element, which could displace one component element of the previous apparatus without altering either the character, the mode of operation of the apparatus as a whole or its results.

Now, it is with this kind of improvement that Interference B deals. It turns upon the invention of that type of transmitter which varies the resistance. Mr. Bell's patent describes such an instrument. It does not merely include the use of such an apparatus under a broad claim for the method, but it describes that type of apparatus known as the liquid transmitter, in which the movement in the transmitter varies the resistance of the circuit. The description of this feature in Mr. Bell's patent has already been referred to on pp. 53, 175, *supra*. It is enough for present purposes to say that the Office finds it there, as every one else has found it there.

Mr. Bell's Case. — The evidence for Bell shows that as early as May, 1875, the date of a letter containing the statement and quoted on pp. 67, 67, *supra*, he conceived the idea that the magneto transmitter, which varied the electro-motive force, might be replaced by a transmitter which should vary the resistance of the circuit supplied with electric energy from a large battery, and that the variation of resistance could be produced by the vibration of a part of the trans-

mitter moved by, and therefore in accordance with, the air waves themselves. Here, then, was a conception of this branch of the art. It only remained to him to find some practical form in which to embody it.

This conception occupied his mind during the summer, and the extracts from early drafts of his specification, prepared about October and November, 1875, and given in the Dward Record, vol. i. p. 487, refer to it.

It is enough, however, for our present purposes, to go to the description in the specification itself. That specification, including the language there found which relates to the liquid transmitter, was written and actually taken to Washington by Mr. Hubbard on the 5th of January, 1876 (Dward case, vol. i. p. 454; p. 71, *supra*). Without further proof, this sufficiently shows the same clear and definite conception of the thing which is found in the patent, and it shows that he considered it to be an invention of importance which he intended to patent as part of his method and apparatus; and, as we have often noted, the actual paper filed on his specification was sworn to on the 20th of January. Now, none of the contestants can go back the 9th or even of the 20th of January, 1876.

It will be observed that this interference issue does not relate to any kind of device for varying the resistance of a circuit for any purpose; it is expressly limited to the case of a speaking telephone transmitter. It is an improvement in the art of transmitting vocal sounds or spoken words, and the electric variations which it creates are to be those which correspond to the vibrations of a diaphragm operated by the movement of the air produced by a spoken word. This is the language of Gray's second claim. Nothing can come up to this issue, therefore, unless it be a speaking telephone transmitter which is to be operated by the sound waves produced by a spoken word, and which is to cause electrical undulations corresponding, not merely in frequency, but in form or quality to the air vibrations which constitute the articulated sound to be transmitted.

Edison's Case. — The instrument of Mr. Edison's interfering application undoubtedly operates to vary the resistance of a circuit by means of a spoken word. It does it by bringing the vibrating diaphragm itself into contact with a large disk coated with plumbago.

He does not pretend to have made the kind of apparatus shown in this application until the beginning of 1877. He bases his claims under this issue upon an entirely different apparatus; namely, what is known as a liquid transmitter, and described in his application 141, Sept. 5, 1877. Can he support the issue to which his application 130 is partly, by proving an entirely different kind of apparatus, first shown in an application filed six months afterwards? Certainly his Office date of the thing he relies on is the date of the application which describes it, and the failure to describe in his earlier application the form now relied on strongly tends to show that, as he made it, it was *imperative* and *urgent*.

We do not, however, desire to take advantage of this for the purpose of dissolving or modifying interferences which the parties have perfectly understood and properly contested. He intends to rest upon some form of liquid transmitter. We have already sufficiently gone over his story in this respect, and it is, that on the back of the translation of the *Reis* article he made, in August, 1875, some rule memoranda; that he did not attempt even to make any instrument during 1875, nor until July, 1876, after he had heard of Bell's success at the Centennial. The most that he claimed, in any part of his deposition, was, that he did try to make an instrument in November, 1875, but that it was absolutely worthless, gave no results whatever, and he threw it away; the clear proof, however, is that he did not make it until the fall of 1876 (c. pp. 199, 274, *supra*).

It is certain, therefore, that he cannot contend with Mr. Bell; first, because he never made an instrument which operated even experimentally, until many months after the grant of Mr. Bell's patent; and second, because he never attempted to make an instrument, or to do anything which could pretend to stand as reasonable diligence to connect his conception — whatever it was — of 1875 with the water telephone that he made in October, 1876.

GRAY'S CASE. — When Mr. Gray testified in the interference case, he had before him Mr. Bell's deposition in the *Dowd* suit, and every detail of Mr. Bell's work which is now in evidence before the Office. He knew, therefore, that Mr. Bell's specification itself carried back his date to Jan. 9.

Nothing in Mr. Gray's testimony gives any earlier date of definite

conception than his sketch, Feb. 11, 1876, and, as in view of the evidence for Bell, he does not undertake to assign any earlier date, it must be taken as admitted that his date of conception was after Jan. 9, when Mr. Bell wrote his specification, and after Jan. 20, when he swore to it. Moreover, even if Mr. Gray had had a conception before Mr. Bell, it is certain that he has no reduction to practice to start from, and no claim of reasonable diligence to connect his more recent work with any earlier conception; he never attempted to make an instrument until July, 1876, after he had seen and read Mr. Bell's patent, and as part of an effort to which Mr. Bell's public success incited him. He did not then obtain any results from it, so that nothing he did at that time was a reduction to practice; and there is not, in his whole evidence, any proof whatever that he ever constructed an instrument of this class, by which he did in fact transmit a single articulate word, until the time when, in the fall of 1877, he constructed the models for his pending application (c. pp. 172, 175, *supra*).

There are two pieces of evidence in his recent bearing upon this which, however, deserve some comment. Mr. Goodridge testified (vol. iii. p. 366) : —

"*Int. 49.* State when, to your knowledge, Gray first practiced transmitting vocal sounds, or spoken words, telegraphically, by throwing upon the line, through the medium of a varying resistance, electric impulses, corresponding to the vibrations of the diaphragm operated by the movements of the air produced by a spoken word, as defined in interference B.

"*Ans.* In June or July, 1876, with the apparatus shown in the preceding answer."

This is a piece of testimony which Mr. Goodridge ought to be thoroughly ashamed of. Mr. Gray (p. 391) refers to this apparatus and the attempt to use it, and distinctly and unequivocally admits that it was at once an failure: the thing itself has never been produced, nor its destruction accounted for. Mr. Goodridge was cross-examined about this answer, on pages 371 and 375. If his forty-ninth answer means anything, it means to convey the impression that Mr. Gray did then transmit spoken words. His cross-examers, 65 to 69, on page 372, are a series of shuffling and evasive replies, in which he tries to escape the confusion of the fact, abun-

shutly shown by those answers, that not a single word was transmitted by the apparatus, and tries to escape it by showing that he has no knowledge of what the results were.

After this exhibition of Mr. Goodridge's knowledge that the thing was an absolute failure, Mr. Gray was examined about this very apparatus and its use (p. 391). And, instead of ascertaining what Mr. Goodridge pretended to assert in his forty-ninth answer, Mr. Gray, in substance, says that the experiment was a total failure. He does, indeed, assign as a reason for it that he had no receiver, but he does not explain why it was that he did not take the trouble to make one, *if he knew how*; nor why it was that he has never since tried that transmitter with a different receiver. The Office must perceive at once the real fact to be that Mr. Gray and Mr. Goodridge made what they considered the best instruments they knew how to make at that time, totally failed to accomplish any result with them, and did not even have sufficient belief in the possibility of producing a result by them to warrant them in repeating the experiment with the same, or of making other instruments for the purpose, until they made the models for those applications in November, 1877, as a part of the scheme of the Western Union Company, already referred to.

VOELKER'S CASE.—Voelker's application states that form of variable-resistance transmitter now known as a microphone, but the facts of his history, already recited in the general consideration of his case, and also under Interference A, are, first, that he did not conceive of any then whatever relating to the employment of electricity for the production of sound until at least as late as the completion of Mr. Bell's specification; that he does not pretend that he attempted to make any instrument until long after Mr. Bell's application was filed, did not complete one until after Bell's patent was granted, and for nearly two years after its issue still failed to produce an instrument which was practically operative to transmit a single sentence; that such instruments as he did make were broken up or thrown aside, neglected until it suited the ambitious purpose of its owner, Irwin, to bring them forward in 1879, more than three years after the grant of Mr. Bell's patent.

Finally, it is also certain that Mr. Voelker never conceived or invented or constructed a speaking telephone; especially, that he

never conceived of throwing upon a line, through the medium of a resistance which varied the current, and without ever interrupting it, impulses which corresponded (in the sense stated by this issue, and necessary for the transmission of spoken words) to the vibrations produced in the air, or in the diaphragm, by the spoken words themselves. (See for Voelker, pp. 116-140 and 178, *supra*.)

Priority on this issue must, therefore, be decided in favor of Mr. Bell, the patentee.

INTERFERENCE G.

This interference is as follows:—

"1st. The transmitter, consisting of the combination in an electric circuit of a diaphragm, and a liquid or equivalent substance of high resistance whereby the vibrations of the diaphragm cause variations in the resistance of the electric circuit, and consequently in the strength of current traversing said circuit." (Gray's first claim.)

"2d. In a telegraph instrument operated by sound, the combination with the diaphragm of two or more electrodes placed in electrolytic liquid, and operating to increase and decrease the resistance of the electric circuit by the movement derived from the diaphragm." (Edison's first claim.)

The parties to this interference are

Bell, patent 174,465, March 7, 1876.

Edison, application 144, Sept. 5, 1877.

Gray, application No. 2, Oct. 20, 1881.

Richmond, application, Aug. 24, 1877.

This is a still further subdivision of Interference B. There are several ways now known in the arts by which the motion of a diaphragm can be utilized to vary the resistance of the circuit, one of these is by variation of contact pressure. This type is commonly employed in the instrument known as the articulating microphone, of which the Blake transmitter is the best known example. The movements of the diaphragm can also be employed to vary the circuit by means of a cup of liquid. If, for example, the wire forming the circuit be bent, and the two ends be brought tolerably close to each other, and enclosed in a cup filled with liquid, the current, if of reasonable strength, will pass through the liquid from one point to the other, but as the liquid offers a much higher electrical resistance than the wire, the current will be considerably enfeebled.

The amount of resistance and the consequent effect on the strength of the current substantially correspond, in a circuit of limited extent, to the length of liquid thus included in the circuit. If, now, one of these points of wire be fixed and the other be attached to a diaphragm vibrated by sound waves, the one attached to the diaphragm will move towards and away from the other as the diaphragm vibrates, and the resistance due to the length of the liquid included in the circuit will thus vary in accordance with the motions of the diaphragm. It is this type of instrument for varying the resistance of the circuit which is the subject matter of Interference C.

Bell shows this in his specification, and his date is carried back to early in January, 1876, by the testimony of himself and Mr. Hubbard, that this specification was then completed. No contestant made such an instrument before the grant of Bell's patent.

Richmond took no proof, and does not contest the case.

Edison relies upon the alleged liquid transmitter already referred to, and the remarks made about it under the previous issues dispose of this.

Gray, also, rests upon the same liquid transmitter shown in his caveat and already referred to under Interference B. The facts which carry that issue in favor of Mr. Bell carry this also.

The issues, as stated, seem to us to be rather vague and indefinite, but the official letter says that they are copied from the first claim of Gray and the first claim of Edison, and, construing them in the light of the specifications from which they are taken, they mean a liquid transmitter, as it is called, for articulate speech, in which one wire or electrode and circuit is attached to a diaphragm operated by sound waves produced by the spoken word, and thereby moved toward and away from another electrode fixed in a cup of water, in which both are immersed.

The Commissioner (15 O. G. 779) defined it as follows:—

"This interference covers one of the devices to be employed in the production of variations of resistance to the electric current by means of sound vibrations caused by articulate speech."

This is shown in Mr. Bell's patent. No contestant had before that grant constructed an instrument capable of doing what the issue declares.

The decision should therefore be in favor of Mr. Bell.

INTERFERENCE D.

"The fluid-holding vertically adjustable tube, within which the ends of the platinum points are immersed, as set forth."

The parties are:—

Edison, application 144, Sept. 5, 1877.

Gray, application No. 2, Oct. 29, 1877.

If this issue has any meaning at all, it is in effect a claim for adjusting the tube which holds the liquid, so that the ends of the platinum points or electrodes immersed in liquid can be adjusted to that distance from each other which is most suitable. This is shown in Edison's application. *b* is the adjusting screw. It is not shown in Mr. Gray's application. Mr. Gray obtains the adjustment by moving the lower platinum point in the tube, instead of moving the tube itself; he does this by means of the adjusting screw *d*. Neither of these gentlemen, however, make any claim to this feature, perhaps because it appeared to both of them that it was quite within the range of the skill of an ordinary maker of electrical apparatus to provide an adjustment for two points, the distance apart of which might be of importance in the operation of the instrument. We may remark, however, that Mr. Bell made the same device, used it, and publicly exhibited it before either of these contestants had it. It is not found in Mr. Gray's caveat, nor is there anything to show its presence in his work until his application in 1877. The screw at the bottom of the liquid cell in the caveat is a binding screw to attach the battery wire to; this is clearly shown in his sketch of Feb. 11, 1876. There is nothing to show its presence in Mr. Edison's work until he constructed his Exhibit Water Telephone instrument in October, 1876. Mr. Bell's Centennial liquid transmitter, of which a drawing is given (vol. III, p. 602), which now exists and is produced in evidence, was actually constructed in May, 1866, and was exhibited at the Centennial in June, 1876. It possesses this feature in the thumbscrew which appears underneath the liquid cup. It may be observed in this connection that Mr. Bell at that time employed an electrode of carbon, and employed mercury as well as acidulated water and other liquids.

The issue is as follows:—

"In an acoustic telegraph, an armature plate, the electro-magnet for the same, and a closed circuit passing from the helix of such electro-magnet to the source of undulatory electric energy." (Edison's third claim.)

The parties are:—

Bell, patent 174,465, March 7, 1876.

Gray, application No. 3, Oct. 29, 1877.

Dubuar, application Oct. 31, 1877.

Edison, application No. 145, December, 1877.

This obviously and by the Commissioner has been decided to refer to the magneto receiver of a speaking telephone combined with the other elements named. The elements referred to are, "an armature plate," an electro-magnet, a closed circuit and a "source of undulatory electric energy," and the issue is not met except by proof of a conception and an apparatus which includes these elements.

The word "undulatory" came into the art from Mr. Bell's specification, and this, taken in connection with the phrase "closed circuit," points to a speaking-telephone apparatus acted upon by sound waves themselves. Mr. Edison's application states expressly that the described apparatus to which this claim relates "reproduces in the resonant tube a sounds that produced the corresponding vibrations and electric pulsations or waves at the transmitter." The issue, therefore, is limited to an apparatus which will transmit speech.

The "armature plate" must mean any piece of metal capable of acting as an armature, and which, by its own breadth or by the breadth and area of any body attached to it, can produce audible articulate sounds. It certainly is not limited to a metal diaphragm, for Mr. Bell's patent 174,465 does not show such a diaphragm. It is not in terms limited to a true diaphragm supported at its edges, though the inclusion of Bell's patent indicates that the examiner meant to give it that meaning.

Such a claim on a receiver, if not limited to a true diaphragm capable of reproducing articulation, or not referring to a true speaking

telephone transmitter as one of the elements to be included in the circuit, would be anticipated by the harmonic telegraph of Varley's English patent of 1870 (Dowd case, vol. II. p. 550).

One element in the combination described is a "closed circuit passing from the helix of such magnet to the source of undulatory electric energy." That is, the circuit which includes the receiver and the circuit which includes the "source of undulatory electric energy" are to be continually closed and not broken by the operation of the apparatus of which the receiver and the circuit form parts. This cannot be fulfilled by placing the receiver in a closed secondary circuit of an induction coil in the primary of which a circuit-breaking transmitter and battery are placed, for it is the battery which furnishes the energy and the transmitter which causes variations, undulations or interruptions to exist in the current. Such a contrivance, moreover, would produce electric interruptions or intermitteances, but not electric undulations, and would not bring into the combination a "source of undulatory electric energy."

This however is not an open question, for the Commissioner construed the issue in this sense before testimony was taken.

In Gray v. Bell, 15 O. G., 779, he said:—

"This device, whether styled a combination or something else, embraces two parts: 1, the armature plate with its electro-magnet; and 2, the closed circuit passing from the helix of the electro-magnet to the device for producing the variations of the electric current. Now the method described in Interference A also includes in a different order two parts closely corresponding to these. That method consists (1) in producing variations or vibrations in an electric current by means of the vibrations caused by the spoken word; (2) in transmitting the electrical vibrations so produced to a remote part of a circuit; and (3) in reproducing by means of the electrical vibrations the same vibrations in the air or other sound medium which were made at the outset by the spoken word. The subject matter of Interference A is the method and not the means or combination of means, while the subject matter of this interference, E, is a device which constitutes a part of the means for effecting the method."

This also is the meaning drawn from the interfering specifications.

Edison's specification says, in the statement of invention, that his invention relates to an acoustic telegraph containing a plate, etc., "in combination with . . . connections to a circuit over which undulatory electric waves are caused to pass." He describes the

source of undulatory electric energy as an instrument which "produces a rise and fall of tension in the main line circuit" in which it is placed, giving to the receiving structure "vibrations corresponding in rapidity, suddenness and extent to those at the acoustic transmitting instrument, thus reproducing in the resonant tube *a* the sounds that produced the corresponding vibrations and electric pulsations or waves at the transmitter." The transmitter, then, is one which is to be operated by sound waves; and the current is to have those peculiar changes which convey "quality," and are technically called "modulations."

Greg's application shows (Fig. 3) two diaphragm instruments arranged, one as magneto transmitter and one as magneto receiver, and connected in a closed circuit, and declares that with this "vocal sound or articulate words spoken at one instrument will be accurately reproduced in the other, both as to pitch and quality as well as tone." This apparatus meets the requirements of the issue, as it states that the receiver is adapted for speech and combined with such a circuit and such a source.

Dolbear's application also shows two magneto instruments connected as transmitter and receiver in a closed circuit, and says that, in operating, one person is to speak to one instrument; then every sound he utters will be faithfully reproduced at the other. A reduction to practice of this invention therefore necessarily requires the presence of the receiver, the closed circuit and included transmitter. Nothing short of this will meet its requirements; nothing less than the use of the whole will demonstrate that the parts can be so combined and are fitted for the work. The conception also must include as much. One who only conceived of or possessed a circuit-breaking transmitter (which is not a source of undulatory electric energy and cannot be in a closed circuit since it interrupts the circuit itself) cannot have conceived of or used this combination. It is quite true that the transmitter might have been the invention of one man; but some form of circuit-preserving, undulatory-creating speaking telephone transmitter, either of his own invention or borrowed from another, must exist in his possession. (See pp. 267-270, *supra*.) Knowing now what will meet the issue, it is easy to ascertain the date of the conception, which shall include it.

We have already sufficiently shown that Mr. Bell is the first inventor of the electric speaking telephone, and that the receiver which is described in his patent 174,465, involved in this interference, was part of the speaking-telephone apparatus invented and described to Dr. Blake in October, 1874. That apparatus, as then described and as afterwards constructed and patented, included all the elements referred to in this issue.

Dolbear's date for conception was after August, 1876, and for reduction to practice was February or March, 1877 (pp. 161, 167, *supra*).

Greg's date for conception was Feb. 11, 1876, the date of his current drawing; his reduction to practice was the fall of 1877, in his models for the application (p. 275, *supra*).

Edison's date was after July 1, 1876, and after he had heard of Bell's Centennial exhibition (pp. 199, 274, *supra*). It is rather difficult to understand why the learned examiner picked out Edison's application 145, and omitted his earlier application 144, which showed it.

The instruments relied on by these contestants as their earliest receivers are more fully considered under G (p. v. p. 292, *infra*).

The decision of priority should be in favor of Mr. Bell.

INTERFERENCE F.

The two issues of this interference are as follows: —

"First. A telephonic transmitter consisting of a coil of wire, one or more magnets and a disk or diaphragm, so arranged relatively to each other that a motion of the diaphragm shall induce in the coil of wire an electro-motive force in virtue of the presence of the magnet or magnets."

"Second. The combination in one circuit of two or more coils of wire, two or more magnets, and two or more disks or diaphragms so arranged relatively to each other that, if one of the disks or diaphragms be put in motion by the voice, by a current of air or otherwise, it shall induce a transient current of electricity in its associated coil, which current shall actuate the other disks or diaphragms in virtue of the coil and magnets associated with them."

The parties are:—

Bell, patent No. 174,465, March 7, 1876.

Dolbear, application Oct. 31, 1877.

Gray, application No. 1, Oct. 29, 1881.

The first issue is obviously on the magnetic transmitter alone, and it would be answered by a speaking telephone magnetic transmitter which had a disk or diaphragm, no matter what form of receiver might be used in the apparatus.

The second issue (formerly H) is the whole speaking-telephone apparatus exactly as shown in Fig. 7 of Mr. Bell's patent, consisting of a magnetic transmitter and a magnetic receiver.

These issues, therefore, contain, as the sole element in one, and as one of the elements of the combination of the other, a magnetic transmitter. They are not limited to an instrument in which the diaphragm is of metal, but include a diaphragm of any material, such, for example, as the membrane diaphragm and attached structure of Mr. Bell's patent involved in this interference.

We have already shown (pp. 176-183, *supra*) that Mr. Gray expressly disclaims the invention of the magnetic transmitter, although, with questionable propriety, he saw fit to describe it in his specification. Mr. Dolbear also (pp. 161-163-165, *supra*) does not claim to have invented a magnetic transmitter, but only to have introduced into it certain improvements after he knew of Bell's invention. Mr. Edison also expressly disclaims it (p. 190).

Both these issues, therefore, must be decided in favor of Mr. Bell.

INTERFERENCE G.

This issue is as follows:—

"A telephone receiver consisting of the combination in an electric circuit of a magnet, and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality." [Substantially Gray's claim.]

"This is substantially described or shown in the applications of Dolbear, Edison and McDonough and in patent of Bell."

The parties are:—

Bell, patent 174,465, March 7, 1876.

McDonough, application April 10, 1876.

Dolbear, application Oct. 31, 1877.

Gray, application No. 3, Oct. 29, 1877.

Edison, application 148, Dec. 24, 1877.

In considering McDonough's case we have already shown (p. 236, *supra*) that this issue calls for an instrument capable of serving as a speaking telephone receiver, and that, considering that actuating currents are both excessively more feeble in the variations and excessively more rapid in the changes which the instrument is to be operated by and convert into audible sound than are the currents due to circuit-breaking transmitters, there can be no conception of this issue unless it be a conception of an instrument to respond to these currents with a full conception of the delicate and intricate character of their changes, and no such reduction to practice as will defeat or control a true speaking telephone patent unless the device was constructed as part of such an apparatus and tried with such currents. (See pp. 236, 237, *supra*.)

This issue does not turn upon the employment of a metal diaphragm, but is met by a suitable diaphragm of any material.

It is not a broad claim for the construction of a "common receiver," that is, an instrument that will respond equally well to all pitches. The Bell receiver would do that, while it will not reproduce speech (see the express testimony of Prof. Morton, vol. III. p. 230, *supra*, and pp. 89, 90, *supra*). The claim includes an instrument which, by its special construction, has the special capacity to reproduce *quality*. Having that, it can of course reproduce all pitches; but the capacity to reproduce all pitches does not imply the capacity to reproduce *quality*.

The issue is not on a receiving instrument alone as a separate structure. It is for such an instrument as we have described combined with an electric circuit; and the circuit is to be one upon which sounds have been so thrown that a suitable receiver can reproduce their quality. The combination stated requires the presence of a current which shall take up the quality of sounds and convey it to the receiver. It is because and only because a circuit furnished with such a

current forms part of the invention that the special capacity named becomes material; and it is only in presence of and in combination with such a circuit, so furnished, that the distinctive characteristics of the receiver becomes operative or can be detected.

Bell's Case. — His date is October, 1874, when he disclosed the invention to Dr. Blake (p. 64, *supra*). His conception then was to use the same instrument (or duplicate) for both transmitter and receiver. June 2, 1875, he made one, and that, under the circumstances, must be considered a reduction to practice for both purposes for which he conceived it, though he did not make a second one (which, when made, was substantially a duplicate, as he intended) until a few weeks later.

Dolbear's Case. — Dolbear's first conception on the subject was in September, 1876, and he expressly disclaims any invention except subsequent improvements. (See pp. 161, 165, *supra*.)

Gray's Case. — Gray's only work which can meet Bell's in date is his wash-basin receiver, made in July, 1874. This was made, used a few times experimentally, lost, and never reproduced. The modified form, shown in the tin cup receiver, made and used January or February, 1875, was experimentally used once or twice and thrown away. They were never reproduced except as models for this case, when Bell's patent was eighteen months old and his instrument had gone into extensive commercial use. Upon this, Gray has no sufficient reduction to practice before Bell's patent to go back from, no diligence to carry him back, and his work of 1874 must stand as an abandoned experiment, only revived by the success of an original inventor and patentee. (See pp. 172, 177, 181, 244, *supra*.)

He never tried them with telephonic currents, and never showed or knew whether they could "reproduce quality."

When Gray drew his caveat, February, 1876, he in effect declared that the instrument of 1874, as he made it, was not capable of acting as a receiver to reproduce quality, or else it had passed out of his mind entirely; it was either condemned or forgotten, both by himself and Goodridge. When they tried to make a speaking telephone they did not employ this instrument. Mr. Gray privately and publicly recognized Mr. Bell as the inventor and lawful patentee of the

whole; he claimed for himself each hour as might flow from the taciturn conception of the *basin* set forth in his caveat, but he claimed no other or earlier conceptions relating to the subject, and he expressly stated that he had made no reduction to practice. See his letters and lecture, quoted on pp. 173-175, *supra*, and a further consideration of the effect of his disclaiming it in his caveat, p. 181, *supra*.

It is quite evident that when Gray first made the wash-basin instrument he constructed it as a *sound reflector* to intensify the sounds due to the molecular expansion of the magnet itself (p. 179, *supra*); he does not tell us when he conceived the idea of producing sound by the vibrations of the diaphragm; he has not, therefore, proved the date of the conception, the burden of which is on him; and, considering that he went to Europe at once, and returned after Bell had made his conception, this is very significant. Moreover, the drawings of his application indicate that he used it by listening at the inside of the basin; this would be right if it were a reflector, but no man would do this if he relied on the diaphragm as the source of sound, for the large magnet would keep the ear six inches away from the diaphragm while the magnet itself would much interfere with the sound. We assert that it is absolutely impossible to receive an *articulate* sound by listening at that side with the ear in the position shown, when employing the transmitter shown in Gray's application or the best transmitter known to the public at its date. It is for Gray to show that this can be done, and this requires substantive evidence in face of the fact that in his caveat he indicated that it could not. (See p. 181, *supra*.)

Furthermore, it will be observed that the magnet of this receiver is of great length, three times as long as those used for ordinary telegraph instruments. Gray of course knew that this, *per se*, was a disadvantage; but, where molecular expansion is relied on as the source of sound, its volume depends on the length of the magnet, and so Gray took a very long one. Reis used one ten inches long (vol. iii, p. 251), and Varley used one eighteen inches long (Dowd case, vol. ii, p. 559, at foot).

It is true that Gray's application is not limited in terms to speech, but it in terms includes it, and expressly asserts for its invention

the capacity to reproduce the quality of spoken words. The commission has decided that this is the proper construction.

Edison's Case.—Edison made an instrument intentionally so contrived that it should, and practically did, exclude the capacity and qualifications named in the issue. He dropped it, and neither continued its use nor attempted to improve it until after he had heard of Mr. Bell's public success. He then tried some instrument, perhaps his old one, found it impracticable, and concluded that he must make one which should be different, though possessing some of the same elements. His early instrument, therefore, was not tried with telephonic currents in 1875, did not, as constructed, possess the capacity named in the issue, and was by Edison rejected for that reason; and it was not connected with his first successful reflection to practice, in the fall of 1876, by any diligence. (See discussion of Edison's case on pp. 208-215, *supra*.)

E. H. Johnson, one of Edison's witnesses, undertakes to swear that Edison's instruments A and A' are not analyzers. But Mr. Edison made them to be analyzers, swore in several applications that they were, publicly asserted in a printed book that they were, and testimony to the contrary now, when need calls for it, from a single uncorroborated witness, strongly interested in his feelings, experimenting to-day with the most recent knowledge and the most powerful transmitters, cannot rescue them from the abandonment in which their specialized and useless character did in fact leave them. (See this further considered among "miscellaneous matters" at the end of these issues.)

Strictly, Edison's application 148 does not meet the issue at all; his applications 120 and 141, however, do, and the evidence has been taken with that understanding, and the issue should be so decided.

McDonough's case has already been sufficiently considered on pp. 235-239, 207, *supra*. This is the only issue he is party to.

Priority should, therefore, be awarded to Bell, the patentee.

Speaking Telephones with Metallic Diaphragms.

Mr. Bell's second patent, 186,787, of Jan. 30, 1877, describes and claims that improvement in speaking telephones which consists

in supplanting the membrane and attached armature of his first patent by a plate of iron, supported at its edges, which can be thrown into operative and accurate vibration at one end of the line, by words spoken, and at the other by the telephonic currents produced in the instrument. We have inferred that some of his opponents meant to contest this invention. But we do not readily perceive an issue which raises it. We therefore state here our views about it, if any issue shall be found which presents the question.

Interference G is a copy of the only claim made by Gray upon receivers in his three original applications of Oct. 29, 1877. It is found in No. 3, called by him "Gray's concave diaphragm receiver application." The claim is intentionally broad enough to include a membrane diaphragm; but the drawing and description show iron diaphragms, and the instrument he relies on to support this application (wash-basin receiver) had an iron diaphragm. We cannot, therefore, state the issue in a manner more conformable to his views than by repeating his claim with the words "of iron or some other inductive metal" after the word "diaphragm." Indeed, as matter of law, Gray's existing claim would be so construed. The claim as drawn is imperative, because it does not contain an armature, and although the reference to the specification would supply this, it would supply it by inserting the kind of armature shown, an iron diaphragm.

An issue or claim, if thus stated, would be:—

"A telephonic receiver consisting of this combination in an electric circuit of a magnet and a diaphragm of iron, or other inductive and elastic metal, supported by its edges and arranged in close proximity to said magnet, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality."

The contestants to such an issue might be:—

Bell, patent 186,787, Jan. 30, 1877.

Edison, application 130, April 27, 1877.

Gray, application No. 3, Oct. 29, 1877.

Dulcior, application, Oct. 31, 1877.

We have already stated (pp. 107, 108 *supra*) that this invention depended upon the discovery, and the utilization of it in a speaking telephone, that an iron plate can be made which shall be capable of

affording mass enough to net as an armature, and at the same time be sensitive enough to respond to sound waves, or to respond with audible violence to those delicate fluctuations of current which are found in the speaking telephone.

Mr. BELL used at his Centennial exhibition, June 25, 1876, an instrument containing this feature. It was constructed (see p. 110, *supra*), about May 10, 1876, and thereafter such instruments were continually used; they were shown in Mr. Bell's specification, prepared in October, 1876. A very finished set of working instruments, with this feature, were constructed in October, 1876, and the model for the application was one of them. They were shown in Mr. Bell's English application, filed in London, Dec. 9, 1876; they were patented in his patent 186,787, Jan. 30, 1877. His date of actual construction of an operative receiver with a metallic diaphragm was, therefore, about May 10, 1876, and that instrument was within a few weeks exhibited and used at the Centennial in a most public manner.

MR. DOLBEAR'S CASE. — Mr. Dolbear's express testimony is, that he first turned his attention to the subject in September, 1876, after he heard of Bell's Centennial exhibition. (See his testimony quoted pp. 161, 162, *supra*.) The first instrument that he conceived of and attempted to make had India-rubber diaphragms, with a piece of iron glued to them. (See his express testimony, p. 166, *supra*.) He never began to construct a telephone with the feature of a metallic diaphragm until after Christmas, 1876, and he did not complete it until February or March, 1877, after he had seen Bell's instruments and congratulated Bell on his invention, without a word of depreciation or reservation. (See his express testimony, p. 167, *supra*.) Mr. Bell, therefore, had publicly exhibited and operated it many months before Mr. Dolbear had first conceived of the idea, and Mr. Bell had actually obtained his patent and shown a finished instrument to Mr. Dolbear before that gentleman completed his own.

GRAY'S CASE. — Mr. Gray's special application for a diaphragm receiver (No. 3) states that his patents 166,095 and 166,096 of July 27, 1876, show "an apparatus for producing musical tones by the action of a series of vibrating electro-tones, whereby several musical notes simultaneously can be transmitted over a single electric circuit through a common receiver."

"Electro-tone" etymologically and technically means a device which "cuts off" an electric current; rheotome, circuit breaker, and current interrupter are equivalent and perhaps more ordinary words for the same thing. As transmitters we know that they control pitch, not quality, and the ability to reproduce pitch is all that the receiver of such an apparatus needs.

The invention which is to be the subject of this specification is, therefore, to be something which shall be different from, and go further than, the above named-patents. This novelty is thus set forth:—

"The object of my present invention is to provide an apparatus capable of accurately reproducing in an electric circuit, not only the different tones, but the pitch and quality of sounds, whether produced by mechanical or the vocal organs; to which end my improvement consists in interposing, in an electric circuit, an apparatus consisting essentially of a diaphragm arranged in close proximity to a magnet, &c."

He then says that the plate is to be thin, preferably circular, preferably of iron or steel, rigidly supported at its edges, "while the central portion, being elastic, is left free to take up and respond to sonorous vibrations of every character." He adds that "the proper proportion, form and mounting of this plate, disc or diaphragm are important conditions." He concludes: "with an apparatus thus constructed vocal sounds or articulate words spoken in one instrument will be accurately reproduced in the other, both as to pitch and quality as well as tone."

His claim concludes with the phrase "whereby sounds thrown upon the line may be reproduced accurately as to tone, pitch and quality."

It is obvious that the leading distinction in practical results between the instrument here described and that of the other patents is, that while both will reproduce pitch, this new one will also respond to those far more delicate electrical variations which serve for the transmission of quality with such practical audibility that conversation can be carried on.

Mr. Bell's patent 186,787 shows an instrument for which these advantages are claimed, and which in fact possesses them. He demonstrated that it did possess them by an apparatus which he made and used in May, 1876, and constantly thereafter.

When did Gray conceive that the described instrument would produce the described result which is to distinguish it from his previously patented device, viz., the reproduction of quality? When did he know and demonstrate that it would do so by actually accomplishing these results himself with an operative instrument?

The answer is that in February, 1876, in a caveat then written, signed and sworn to, he stated in effect that such an instrument would not; and the first attempt to do it that he ever witnessed was the accomplishment of it by Mr. Bell with his own instrument June 25, 1876, at the Centennial (pp. 181, 183, *supra*).

That the metallic diaphragm would operate successfully for this purpose was contrary to the existing state of knowledge, and contrary to Mr. Gray's own belief, as expressed in February, 1876.

Mr. Bell patented this instrument, and, fifteen months afterward, Mr. Gray comes forward to say that he had invented it and reduced it to practice in 1874, and thus to defeat Mr. Bell's patent. On this statement of the facts it is clear that Gray had not made an instrument and operated it with such success as to demonstrate that it would accomplish what his application and Bell's application now assert for it. The statement in his caveat specification is that the only thing fit for that purpose was "*some thin substance, such as parchment or goldbeater's skin, capable of responding to all the vibrations of the human voice, whether simple or complex.*" It is clear, therefore, that nothing Mr. Gray did in 1874 or 1875 even left on his mind the impression that a plate of sheet-iron had that capacity or could be used as a speaking telephone, and he never had so much as it at the time Mr. Bell took out his patent on his invention. It would be absurd to say that Mr. Gray had made the invention when all he had done was to devise such an apparatus for another purpose, where it would be operated by forces entirely different in their character and violence, and had then declared that it was unsuited for the delicate forces which existed in the speaking telephones. It is to be remembered, also, that his assistant, Mr. Goodridge, who made the instrument of 1874-5, aided in the preparation of this caveat (vol. iii. p. 363, ans. 37), and he did not suggest that a speaking telephone receiver could be made with a metal diaphragm. See pp. 181, 183, *supra*.

The summary of Mr. Gray's work is as follows: he did construct, for a different purpose, and to be operated by different force, an experimental model which contained a metal diaphragm and an electro-magnet. He employed it for no useful purpose; lost it and did not reproduce it or patent it. Since Mr. Bell obtained his patent it has been, for the first time, ascertained, by means of or as a consequence of Mr. Bell's specification and actual use, that Gray's instrument can serve for speech, though very imperfectly. But the knowledge that an iron diaphragm can be used in a speaking-telephone with advantage is due to the original invention of Mr. Bell. When Gray made the instrument the state of the art coupled with inspection of his apparatus did not teach men that it could be so used. No use or experiment by him demonstrated that it could be. On the contrary, the impression left on his mind was, that it was so unsuited for the purpose that its use was not to be mentioned in connection with the speaking telephone, even as a possibility.

The tin-cup device used in February, 1875, never appears again: nothing that answers the issue ever appears again until Mr. Gray constructed one in October or November, 1877, to serve as a model in this case (p. 177).

That he treated it as an abandoned experiment is clear from another circumstance. When he came to draw his caveat it is certain that if this had been present in his mind as a useful thing or a substantial thing, his drawing, or his description, would have given some indication; but his drawing is of a totally different character,—shows a different kind of case, different kind of figure; it is certain that no man who had the wash-basin instrument or the tin-cup instrument present in his mind as a thing which could be used, would have made the drawing of the receiver of the caveat. It is a fact clearly proved, therefore, that these instruments had either passed out of Mr. Gray's mind entirely, or that the experiments with them had satisfied him that they were totally useless for the purposes of speaking telephones; there is no pretence of their practical utility for any other purpose.

It is to be observed, also, that Mr. Gray himself listened at Mr. Bell's metallic diaphragm receiver on June 25, 1876, at the Centennial, yet even that did not cause him to remember his old instrument

or to claim it, or to make another one like it. He afterwards corresponded with Bell, and referred to their relative claims, admitting Bell's priority in large and general terms. Never, to Bell or to any one else (until the Western Union put him forward in October, 1877), did he allude to any claim on his part to the prior construction of a receiver. He says that a few days after the Centennial exhibition he tried to make a speaking telephone, but he did not try to make or to use that receiver with it, nor did he ever attempt to reproduce it for the purpose of speaking telephones, so far as the evidence discloses, until he made his model at the request of the Western Union, in the fall of 1877. It would be perfectly absurd to say that his apparatus of 1874 and 1875 went beyond an abandoned experiment; it would be still more absurd to say that the models he made for the Patent Office in the fall of 1877 could be construed by a chain of "reasonable diligence" and unmitigated exertion with his washbasin and tin dipper of 1875. The details of Mr. Gray's evidence on this topic are on pp. 176-183, *supra*.

It would be difficult, therefore, to state a stronger case of an instrument which was made merely for an experimental use, as a matter of show and not of utility, lost or broken up, forgotten, declared by him to be worthless and unimportant for the purposes for which he now wishes to patent it; and yet, that is the only basis upon which, at the present time, he seeks, by patenting the receiver, under an application made fifteen months after Mr. Bell had publicly used it, with his knowledge and without assertion of claim by him, to control the great invention of the speaking telephone which he confesses he did not make, and which Mr. Bell did make.

EDISON'S CASE.—Mr. Edison's case is disposed of by the same lines of remark. He did make, in November, 1875, precisely the analyzing resonator which is shown and claimed as an analyzing resonator in his application 148.

Of course it was not and could not be practically operative as a speaking telephone receiver. He never tried it as a speaking-telephone receiver, and never demonstrated that it was fit for that purpose. In the summer of 1876, after he had heard of Mr. Bell's exhibition, where Mr. Bell used a metallic diaphragm receiver, he experimented with such an apparatus, and the result he expressly

declared was, that metal diaphragms, as he made them, were found to be unfit for use in a receiver, and thereupon, in the instruments which he constructed all through the autumn of 1876, he invariably employed, and in his sketches invariably directed, the employment of parchment diaphragms. In the instrument which he made as his earliest model for his earliest application he first had a parchment diaphragm. After Mr. Bell's patent had been out a fortnight and presumably come to Edison's hands, and after Mr. Bell's exhibition and lecture at Salem, reported in the papers of February 15, 16 and 17, where he used, according to these reports, a metallic diaphragm instrument, then, for the first time, Mr. Edison appears to have followed the idea that a metallic diaphragm would be suited for a speaking telephone, and thereupon caused another model to be made in which a metal diaphragm was substituted for the membrane. (See pp. 213-215, *supra*.)

It cannot be pretended that Mr. Edison had before that operated a telephone with a metal diaphragm with such success as to demonstrate that, for the purpose intended, the metal was an improvement over the membrane, for he had expressly declared the contrary to be the opinion he entertained as the results of his experiments. Nor can it be pretended that the instruments he made in the spring of 1877 were connected back by any chain of diligences with anything he did in 1875, because, from the time that he made, in November, 1875, the instrument which he relies on, but which we have shown was not a speaking-telephone receiver at all, he did absolutely nothing more on the subject until after he had heard of Mr. Bell's success with this very kind of receiver at the Centennial, and then he was so far from apprehending the invention that he used membranes for eight months afterwards, believing he could do no better. This part of Mr. Edison's case is considered at length on pp. 208-215, *supra*.

It is clear, therefore, that at the time when Mr. Bell took out his patent, Jan. 30, 1877, and still more at the time when Mr. Bell first made a speaking telephone with a metal diaphragm, in May, 1876, neither of his opponents had ever constructed and operated such an apparatus; they had not proved by experiment, nor did they even believe, that it was possible to employ a metal diaphragm with

any practical success in a speaking telephone. Now, that is not the condition of a man who claims that *improvement* in speaking telephones which consists in substituting a metallic diaphragm for a membrane diaphragm.

Remarks of Messrs. Goodridge and Gray about this issue.

The depositions of Messrs Gray and Goodridge exhibit a curious misapprehension of what constitutes a speaking-telephone receiver with metallic diaphragm. They intimate that the blacking box of Gray's patent 166,066, July 25, 1875, is such an apparatus. It certainly is not, for it does not have a diaphragm supported at the edges and free at the centre. It is simply a species of sounding box, and is described as such in the patent. A sounding box adapted for this purpose, to act like the body of a violin, was described and used by Reis (vol. iii, p. 252), and by Varley (Dowd case, vol. ii, p. 457). The Office did not put that patent into the interference, and Mr. Gray's application No. 3 sharply draws the distinction between the instruments of 166,065, which can reproduce pitch, and the true diaphragm receiver which can reproduce quality. (See the quotation, p. 298, *supra*.) Moreover, this issue relates to a true magnetic receiver in which the diaphragm is to be of iron or some inductive metal which can act as an armature. Gray's patent says that the box there described is to be of *any metal*. The language of that patent is (Dowd case, vol. ii, pp. 579, 581):—

"My invention relates to what I term an 'electro-harmonic telegraph,' and is based upon the fact, well known to electricians, that an electro-magnet elongates under the action of the electric current and contracts again when the current ceases. Consequently a succession of impulses or interruptions will cause the magnet to vibrate, and if these vibrations be of sufficient frequency, a musical tone will be produced, the pitch of which will depend upon the rapidity of this circuit. If the receiving electro-magnet is connected with this circuit, it will be caused to vibrate, thus producing a tone of corresponding pitch, the sound of which may be intensified by the use of a hollow cylinder S of metal, placed on the poles of the magnet."

The electrical vibrations were caused by a circuit breaker.

It is obvious that the sound was due to the in denture expansions of the magnet, and that *this* was the sound which was heard, in-

tonified by the large area of the box resting on the magnet. The lower face of the box rests on the magnet; the upper face is too far off to be affected, and it is declared that the purpose of the invention are secured if the box be of *metal*, without regard to whether it be a metal capable of acting as an armature or not. No such box exists in the metal; there is no evidence whatever that it was ever filed in the Office. The patent clearly, therefore, does not set forth the invention of an *inductive* diaphragm, supported by its edges and vibrated by the varying attraction of the magnet.

The fact that he put this into a patent and made no claim for and attached no importance to a true diaphragm instrument (if he had one) until long after Mr. Bell had patented and publicly used it is conclusive proof that he had not done enough to overthrow Bell's patent.

We have discussed this as if there were a real issue on the invention of that improvement in speaking telephones which consists in the employment of an iron diaphragm. But in truth there is no such issue nor anything to raise one. Mr. Bell had a patent many months old. No interference is raised, unless some applicant, both shows and claims it; Mr. Gray's four applications contain no such claims. There is no claim in his application which would be rendered invalid by proof that he was not the first inventor of the iron diaphragm. The Office at first so read his claim which forms issue G, but upon informing him that this was considered a mistake and that the interference would be declared with Bell's membrane diaphragm instrument, and not with the other, he declared that to be the construction intended, and declined to make any claim which would interfere with Bell's second patent (vol. iii, p. 326).

Edison claims several combinations and special forms in which a metal diaphragm appears, but none of those claims (if we are right in our construction of issue J) would be invalidated by the prior invention of all that Bell shows or claims in this respect in his second patent.

Dolbear's third claim (p. 440) comes more nearly to it, and perhaps taken in conjunction with his specification, may be read to cover it, but that claim cannot, as applied to any controversy or any subject matter presented, be distinguished from his first and second claims.

His case, however, is of no importance, since his date of conception is long after Bell's public use of his Centennial receiver.

But whenever and wherever the question may be raised, Mr. Bell must be adjudged to have a valid patent as the first inventor of the thing.

INTERFERENCE 1.

This contains two issues, which are as follows:—

First. "A telephonic transmitter consisting of one or more helices, forming a portion of the main circuit, and surrounding a core or cores maintained in a magnetic state by the inductive influence, either of an electric current or of a permanent magnet in combination with an electric inductive plate or armature, which is rigidly supported at one or more of its edges, while the portion facing the poles of the magnetic core or cores is left free, so as to be capable of responding to sonorous vibrations traversing the atmosphere or other bodies.

[This is substantially Dolbear's first claim, and is substantially embraced in Bell's third and eighth claims. It is described in application of Gray.]

Second. "Two iron or steel cores respectively mounted upon the opposite poles of a permanent magnet receiving magnetism therefrom by induction, and provided with enveloping helices of insulated wire, which form a portion of the main circuit in combination with an elastic inductive plate or armature rigidly supported at one or more of its edges, while the portion thereof facing the poles of the magnetic core is free, so as to be capable of responding either to sonorous vibrations traversing the atmosphere or other bodies, or to magnetic electric pulsations or undulations traversing the helices surrounding the magnetic cores." (Dolbear's second claim.)

"This is described and shown in Bell's patent."

The parties are:—

Bell, patent 186,787, Jan. 30, 1877.

Gray, application 1, Oct. 29, 1877.

Dolbear, application of Oct. 31, 1877.

The first issue describes a speaking telephone magneto transmitter, which, in its construction though not in its principle, is an improvement upon the transmitter shown at A, Fig. 7, of Bell's first patent. The improvement consists in replacing the membrane diaphragm and attached armature of Bell's first patent by what the issue calls an "elastic inductive plate or armature." Every other part of

the issue describes features shown in instrument A of said Fig. 7, so that if in this issue you substitute the words "elastic diaphragm" carrying an inductive armature," you would have exactly the instrument of Mr. Bell's first patent. The novelty consists, therefore, in contriving that a single plate shall serve both as an inductive armature and as an elastic diaphragm in a telephonic transmitter. It will be observed that it is not *any* plate, but it is a plate such as is described in the three applications and as corresponds to the diaphragm of Mr. Bell's first patent, to wit, one supported at its edges and free at its centre, that is, not touching anything at its centre.

This issue refers to the employment of a permanent magnet, but it does not claim it, nor make it an essential feature, for it says that the cores may be maintained in a magnetic state, so far as this claim is concerned, in either of two alternative methods, that is, by the employment of a battery current, such as is shown in Fig. 7 of Bell's first patent, or of a permanent magnet, such as is shown in the second patent. The claim, therefore, does not turn upon the presence of one rather than the other of these elements, but it is solely a claim for the employment of the *metallic diaphragm of inductive metal*, supported at its edges and free at its centre, in a telephonic transmitter which is otherwise the same as that of Mr. Bell's first patent.

We have already seen that Mr. Gray does not pretend to have invented or used a magneto transmitter (p. 176, *supra*). He claims that he made a receiver which could be reversed and used as a transmitter, but a magneto transmitter is a distinct invention from a magneto receiver, because it involves a new and independent discovery and the employment of different principles or laws of nature. For the transmitting instrument, in the electrical point of view, makes use of the magneto-electric induction of currents which practically and scientifically, as well as in its history, is a different discovery from the discovery that the variations of an electric current could produce varying magnetism. The magneto transmitter also depends upon the discovery that a plate or diaphragm carrying an armature heavy and thick enough to operate as an inductor, electrically and magnetically, can still be thin enough to be vibrated by the sound waves of the air with sufficient violence to produce prac-

tical audile effects. We have no occasion, however, to discuss this question, because the Commissioner in this case has expressly decided that the inventions are different. In *Bell v. Gray*, 15 O. G. 779, he says:—

"The fact that the receiving device as used in Interference G would enable an undulatory current of electricity to reproduce, at the point of delivery, the same sound vibrations which had been caused by articulate speech at the starting point, was not enough to suggest to the skilled workmen or electricians that the same device would, if reversed, enable the sound vibrations caused by the spoken word to cause such variations of the electric current as to reproduce, at a remote point on the circuit, the same sound vibrations. If the invention of this transmitter was suggested by the receiver, it was none the less an invention in the sense of the law."

Mr. Gray, therefore, never invented the telephonic transmitter described in this issue; he never used one nor sought to use one until after the grant of Mr. Bell's second patent.

Mr. Dolbear's claim is, that, taking Fig. 7 of Mr. Bell's first patent, which would not meet this issue, he altered it by substituting a metal diaphragm for a membrane diaphragm and attached armature, and that the invention described in the issue consists in this alteration.

Mr. Bell's historical Contention receiver had a metallic diaphragm, which, as a structure, would answer this issue. It was undoubtedly intended as a receiver, but *Mr. Watson* distinctly testifies that before it was taken to Philadelphia it was by him used as a transmitter (p. 110, *supra*). Next, *Mr. Bell*, about July 1, did actually construct a plate to be used as a transmitter, which now exists, and has been put into the Dwell case on complainant's Exhibit No. 45. A drawing of it is found facing page 104, vol. II, Dwell case.

Its construction and use are testified to by *Mr. Bell* and other witnesses (p. 110, *supra*). He continued to use metal more or less, using the membrane diaphragms during the summer of 1875, and he actually made the most improved form of transmitter then constructed, with a metal diaphragm, and used it in October, 1876. It was one of this pair of instruments which was the model for the second patent; it is a full-sized working instrument. A memorandum

made a few weeks afterwards and put into the record describes it and shows its character (p. 110, *supra*).

Now, either of these dates will antedate what *Mr. Dolbear* did, for *Mr. Dolbear's* first attempted instrument, never actually constructed, but only begun and worked upon first during the last of September or first of October, had a rubber diaphragm with an armature glued on to it. Some time after that—he does not say how long after—he determined that "probably" it would be better to make the diaphragm of iron (p. 166, *supra*), but he never even began to construct a telephone with such a diaphragm until after Christmas, 1876, and did not complete it until the last of January or first of February, 1877 (pp. 166, 167, *supra*). His first conception, therefore, was certainly after *Mr. Bell's* instrument of July, probably after *Mr. Bell's* instrument of October. Before *Mr. Dolbear* began the construction of such a telephone, *Mr. Bell* had made it in finished form, had used it and had described it in his English specification which was filed in London, Dec. 9, 1876, two or three weeks before *Mr. Dolbear* began his construction; and, finally, it is clear, on *Mr. Dolbear's* own testimony, that he had never completed an instrument of that kind until after the grant of *Mr. Bell's* patent. *Mr. Dolbear* was, therefore, the last to conceive, the last to construct, and the last to come to the Office.

The next issue of Interference I, namely, the second, which formerly formed Interference K, turns upon the employment, in an electric-speaking magneto transmitter and receiver, of a permanent magnet to magnetize the cores in place of a battery and current to magnetize them. The other described features of the instrument are the elastic inductive plate supported at its edges and free at its centre. The issue describes and requires the use of this device, both in the transmitter and the receiver, because, by its express terms, the instrument is to be one which is to be capable of responding either to sonorous vibrations traversing the atmosphere, or to the electrical undulations passing through the helices. It is virtually the contrivance referred to in the eighth claim of *Mr. Bell's* second patent.

Mr. Gray is not a party to this issue; by the express terms of the declaration it is between *Dolbear* and *Bell*.

Now, Bell's first conception of his instrument in 1874 embraces the use of a permanent magnet. Later he again resorted to it. July 2, 1876, he writes, "I am sure that by substituting a permanent magnet for the electro-magnet, I can work it without a battery at all" (p. 109, *supra*). He immediately caused a permanent steel magnet to be made for this purpose, of a size and shape to fit his existing Centennial telephone, and it was delivered to him by the manufacturer July 15, 1876. He used it at once, and the magnet was produced and its date fixed by the books (p. 189, *supra*).

Before November 12 he had actually carried on a conversation between Boston and Cambridge without a battery. Working instruments of this kind of a finished character were constructed, and permanent magnets placed in them about the middle of November, 1876. The specification for the English patent was filed in London, December 9, and therefore necessarily sent there about the middle of November, describes and claims this feature. One of these instruments, provided with a permanent magnet by the middle of November, 1876, constitutes the model for this application (pp. 109, 110, *supra*).

Mr. Dolbear's first conception of the employment of a permanent magnet was on the 20th of September, 1876, when he made a memorandum; but this instrument never was constructed; it was begun, and dropped unfinished. He began the construction of his first telephone, which had this in it, he says, after Christmas, 1876, and he completed it the last of January or the first of February, 1877. Thus his first conception of it was after Mr. Bell had actually made and used his magnet of July, 1876; his first construction was begun after Mr. Bell had completed and employed commercially perfect working instruments with this feature and described and claimed it in his English specification, and was preparing his United States specification. Mr. Dolbear did not complete his instrument till after Mr. Bell's patent had issued.

It must not be forgotten, also, in considering Mr. Dolbear's claims, that he was guilty of the utmost *leaches* in presenting himself at the Office, and that he has exhibited himself in a light very unfavorable for his credit to the consideration of any pretence or claim on his part. (See his case, pages 162-168, *supra*.)

The Commissioner thought that these two issues were the same, and directed that they be consolidated; but this never has been done, and it is obvious that he was mistaken.

There is one possible limitation to this issue, which introduces a very narrow meaning to it, and that is, that the instrument to meet the issue must have, not only the feature of a permanent magnet and a diaphragm supported at the edges, but must employ a magnet with two poles facing the diaphragm — that is, a horseshoe magnet — as distinct from a single pole or bar magnet, and that this horseshoe magnet must have at its two ends the two iron or steel cores. If this be the true meaning of the interference, it does not really meet the controversy between the parties, for, if it be limited to the special use of a horseshoe magnet, as distinguished from a bar magnet, it only touches one of the two forms shown as equivalents in the application of Dolbear and the patent of Bell, and it only touches that form which, in practice, has been found the least convenient and useful. Nor does it touch that form in its most desirable condition. The permanent magnet must necessarily be of steel in order to retain its magnetism. Mr. Bell points out that instead of winding a coil around a piece of steel, it is advantageous to mount what he calls pole pieces, or small cores of soft iron at the ends or end of the magnet, and wind the coil around that soft iron and piece. The special advantage of that is, that while the soft iron is highly magnetized by the steel magnet to which it is attached, yet it will change its magnetic condition very much more readily and quickly than a piece of steel of the same size would; and one of the special advantages of Mr. Bell's apparatus shown in his patent consists in this combination of soft iron and steel. (See the instruments figured on pp. 112-114, *supra*.) This is indeed shown and described in Mr. Dolbear's application. Now, the advantage of this special combination is found when soft iron cores are mounted on a steel magnet; but to mount steel cores upon a steel magnet is merely a mechanical variation in the manner of constructing it, which does not rise to the dignity of an invention, and which in effect is merely a modification in the form of the magnet. For the advantages of Bell's form, see p. 106, *supra*.

If this issue be taken to be limited, then it does not meet the real

controversy between the parties. If it turned on this alone, Mr. Dolbear could not prevail. His sketch of Sept. 20 shows the simple bar magnet of steel; that is, his memorandum states it is to be a permanent magnet (vol. iii. p. 445). The part surrounded by the helix is of the same size as the rest of it, and is not a separate core mounted on it. Upon a narrow construction this would not meet the issue. There is no evidence at all in Mr. Dolbear's deposition when he had the idea of utilizing both poles, or using a horseshoe magnet, except so far as it may be gathered from his actual construction, and that construction, as we have seen, was begun after Christmas, 1876 (p. 167, *supra*); that is, long after Mr. Bell's conception and statement of it, proved at least by his English specification, prepared in this country in October or November, and filed in England the 9th of December; and Mr. Dolbear did not actually complete this instrument until after Mr. Bell's patent was issued (p. 167, *supra*). Bell's instrument of July 15, 1876, had a double-pole horseshoe, permanent steel magnet.

In the next place this instrument, produced by Mr. Dolbear as made in February, 1877, does not have two cores separately made and mounted upon the opposite poles of a permanent magnet. It has a permanent steel magnet, with spoons over the ends of it, and it does not fully accomplish the advantageous results which Mr. Bell derived from the small soft iron core mounted on the end of the permanent magnet. Mr. Dolbear's *application* says, that he prefers to use the compound horseshoe magnet, made up of plates, with a core screwed or fastened into one end of it, as shown in his drawings.

He was asked when he made this invention, which is the subject of the second claim (issue 2 of J), and he said (p. 452): —

"*Ans.* I first employed the iron poles in combinations with permanent magnets to adapt the commercial magnets to the purposes of telephony, probably in March, 1877."

This was after Bell's patent was granted, and after Bell had publicly used the instruments at his Salem lecture, and they had been described in the papers, and Dolbear had seen them.

Upon this construction of the issue, of course, priority rests with Bell.

We think that the issue should be construed to cover broadly the use of the permanent magnet instead of the simple electro-magnet and magnetizing current. If so, priority should be awarded to Bell, the patentee, because he actually constructed and used the instrument in July, whereas Dolbear did not conceive of it until September, and did not use it until after the grant of Bell's patent.

If it be limited to the use of a magnet provided with special cores, priority should be awarded to Bell, because Dolbear neither made nor conceived of this structure until after the grant of Bell's patent.

Every one knows the great use of the magnet receiver corresponding to this issue and first introduced into public use by Mr. Bell. For a long time these instruments were the only transmitters employed, while now there are 25,000 magnet instruments used as transmitters in the United States (Watson, *cross-ex.* 67, p. 726, vol. iii.). It is well known that in Germany nearly all the transmitters in use are magneto instruments.

This interference is as follows: —

"The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for rendering audible [acoustic] vibrations. [Editor's first claim.] This is substantially embraced in Bell's third claim and Dolbear's three claims, and described in application of Gray."

The parties are: —

Bell, patent 186,787, March 7, 1876.

Dolbear, application Oct. 31, 1877.

Gray, application No. 3, Oct. 29, 1877.

Edison, application No. 148, Dec. 24, 1877.

It is impossible, by any of the ordinary rules of construction, to assign to this issue any meaning which raises an interference between these several parties on these applications and patent. It relates to a combination which contains an electro-magnet, an iron diaphragm and a "resonant case," to which the diaphragm is attached. There is no difficulty in understanding what is meant by the electro-magnet and by the iron diaphragm; what is the significance of the word "resonant"? It is not any case, but a "resonant" case which is called for.

Referring to Mr. Edison's application 148, from the first claim of which this issue is taken, we find that the element there stated is, "a resonant case for rendering audible acoustic vibrations, substantially as set forth." That application has nothing whatever to do with the transmission of speech. Its declared object is described to be a harmonic multiple telegraph, worked by ordinary Morse keys, shown in the drawing as H and K. The specification then states that the invention relates especially to an apparatus which produces sound at a distant station, and "separates each series of waves so as to render them audible only in that instrument with which they are in unison"; in other words, the invention relates especially to an analyzing receiver. This, as we well know, is of utility, and, in fact, almost of necessity, in an harmonic multiple telegraph, but is fatal to any attempt to transmit articulate speech (c. pp. 65, 192, 209, *supra*). The analyzers of this specification are contrivances shown in Fig. 2 of the drawing. They consist of diaphragms mounted on the ends of Helmholtz telescopic analyzing resonators, which the specification styles "resonating tubes." The specification then states that the object of these tubes is to give a particular tone to the included column of air, so that one will respond audibly to vibrations of one pitch only and will extinguish all others; and that the other will respond audibly to vibrations of a different pitch, and will extinguish all except that. When, therefore, the claim specifies as one of its elements "a resonant case, substantially as set forth," it means a case so constructed and arranged that the peculiar shape given to its air space acts as an analyzer, as described in the statement of invention and in the body of the specification.

This is the accepted meaning of the phrase. "Knight's Mechanical Dictionary," (one Resonator), says that by its employment

"Tones above or below the pitch of the resonator will be but imperfectly heard; but if a note be sounded corresponding to the positive note of the resonator it will appear greatly intensified."

Now Mr. Bell's patent 126,787 shows in front of the diaphragm, and intervening between that and the listener, an air space which, instead of being constructed and contrived like a "resonator," to select a particular tone, is peculiarly shaped so as to have no bias of its own, and render all pitches and qualities of tone with equal fidel-

ity, amplifying none, extinguishing none. It would be, of course, a mere trick of language to institute an interference between the device, called by Mr. Edison a "resonant case," for the purpose of analyzing or destroying sounds, and a device called by Mr. Bell a sound box, or sound chamber, and so contrived as to prevent any analysis or destruction of sounds.

Mr. Gray shows a sound box, it is true, but it is one which does not have the peculiar elements and advantages of Mr. Edison's for the purpose of analyzing; nor of the peculiar elements and advantages of Mr. Bell's for the purpose of preserving the intricate and peculiar and special qualities of all sounds.

Finally, Mr. Dubnair has nothing at all which can answer to the phrase "resonant case." He made a hole in a piece of board and fastened his diaphragm to one side of it, and said a hood might be attached to enclose the speaker's mouth or listener's ear. No one can pretend that the aperture was operative in any sense to affect the character of the sound.

The learned examiner who declared this interference said that the subject matter of interference was substantially shown in Mr. Bell's third claim and in Mr. Dubnair's third claim. Mr. Bell's third claim indicates an iron diaphragm supported by its edges, without regard to the character of the case or air space connected with it, although his drawing and his description show and elsewhere he claims the peculiar air space invented by him. Mr. Dubnair's third claim is clearly also for the iron diaphragm alone, rigidly supported at its edges and free at its centre, without regard to the form of the air space obtained by any peculiar shape of case.

Mr. Gray's application is to the same effect, and if these were all the parties, there would be no difficulty in determining that this interference covered that improvement in speaking telephones which consists in the employment of an iron diaphragm instead of the membrane diaphragm and attached structure of Fig. 7 of Bell's first patent. But when we come to Mr. Edison's 148, we find that that is not an application for a speaking telephone; that the receiver there shown is totally unfit for a speaking telephone receiver, and that the special elements which it is the object of that application to set forth as a new invention in a receiver are such as would unfit it

for a speaking-telephone receiver and would fit it for a harmonic multiple telegraph, and this special feature is the "resonant case" expressly mentioned in his claim and in the issue.

It may also be remarked in this connection that Mr. Edison is the only person who shows an analyzing resonator to attach the diaphragm to, while Mr. Bell is the only person who shows the shape of the air space specially intended and adapted to secure the unchanged transmission of sound waves, namely, the thin air-space now universally used all over the world for this purpose.

Mr. Gray intimates that the wash-basin was a resonant case. It cannot be pretended that there is anything in this form to anticipate either the analyzer of Edison or the thin closed air space of Bell.

Mr. Gray also says that the instrument shown on p. 419 meets the issue. It does not have a diaphragm, but a strained and fairly well tuned strip of steel, not attached to the "resonant case." The resonator is an ordinary glass Helmholtz analyzer. This has no bearing on Mr. Bell's device, nor on anything used in a speaking telephone. What bearing it may have on Mr. Edison's analyzing resonators we do not care to inquire.

So far as any interference exists with anything heretofore referred to and shown in Bell's patent, priority should be awarded to him.

INTERFERENCE L.

First. "The combination in an acoustic telegraph of an electro-magnet, and a polarized armature formed of a plate of iron, steel, or other material capable of inductive action, and a resonant tube or case." (Edison's first claim.)

Second. "The combination in an acoustic telegraph of an armature plate polarized by induction, a resonant case or tube, and an electro-magnet and circuit connections whereby reverse currents are caused to act in the electro-magnet with varying intensity proportionate to the electric waves sent from the transmitting station." (Edison's second claim.)

The parties are:—

Bell, patent 174,465, of March 7, 1876.

Edison, application 145, Dec. 13, 1877.

Gray, application 4, Jan. 17, 1878.

Both issues include as one element what is called a "resonant tube or case," referred to in the preceding issue, *J*. The learned examiner who declared these issues did not understand the meaning of the word "resonant," and that is still more clear in this interference. These two issues involve Mr. Bell's first patent and Mr. Edison's application 145; neither of these have the specialized shape of a Helmholtz analyzer, nor the specialized shape of Mr. Bell's thin air-space of his second patent. Mr. Bell's patent shows simply an ordinary listening tube. The only functions that it serves are to form a support to the diaphragm and to convey the sound to the ear undisturbed by outside vibrations; neither of these functions are described by the term "resonant." It may be taken, therefore, that "resonant tube, or case," means, under this issue, as under the preceding one in which Dolben's application is concerned, any kind of a ring or frame for supporting the diaphragm.

It is clear that the matter of this first issue does not relate to the devices shown in Fig. 5 of Mr. Bell's patent, because that figure contains nothing in the nature of a resonant tube or taken or supporting frame of any kind; it must refer to a contrivance substantially like that shown in Fig. 7, which consists of a diaphragm and attached armature mounted on a case or frame. The particular feature covered by this issue consists in polarizing or magnetizing the armature, so that of itself it is a magnet. This is done in Mr. Bell's case by attaching one end of the armature to one leg of a horseshoe magnet, the magnetism of which is imparted to the armature by induction, so that the armature itself becomes magnetic. In Mr. Gray's application the armature plate consisting of an iron diaphragm is also attached to one leg of a magnet, which is magnetized by a coil on the other leg supplied with a battery current.

In Mr. Edison's application the non-vibratory end of the armature is attached to a permanent magnet.

The invention is a very narrow one, because the employment of a polarized armature in an electric apparatus is quite old.

There are two, or perhaps three, purposes for which polarized armatures have long been used in telegraphy. The well-known Siemens armature, so called, which is described in Preece and Sivewright's book (quoted in Mr. Goodridge's deposition, bottom of page

385), is an ordinary example of it. In this instrument the free end of the armature is mounted on a permanent steel magnet, from which it derives its polarity. Its free end is placed opposite the pole, or between two poles of an electro-magnet. In this construction, the magnetic armature has its sensibility increased by being polarized. Its permanent polarity is not sensibly affected by the operation of the instrument. Now, the north pole of a magnet will attract a south pole and will repel a north pole. If, therefore, the free end of a magnetized armature, so magnetized as to present the south pole, be placed opposite an electro-magnet, and a current be sent through that electro-magnet in such a direction that its end becomes the north pole, it will attract the armature. If the current be reversed in the electro-magnet, its end becomes a south pole, and it will repel the same magnetized armature, whereas it would still attract a neutral or unmagnetized armature. It has also sometimes been considered that an armature magnetized so as to present its south pole opposite an electro-magnet, the current of which makes its end a north pole, is more violently attracted than a neutral or unmagnetized armature would be. This, abstractly, would be true, but these contrivances introduce so many other elements that this device, we understand, has not been found to add practically to the strength of the apparatus. The Varley patent (Dodd case, vol. ii, p. 552) exhibits in one form of receiver a magnetized harmonious tongue, or reed, worked by reversed currents, the reversals of which are obtained by the employment of an induction coil combined with a circuit-breaking transmitter. We do not consider that this anticipates the matter set forth in this issue as we construe it, but it serves to show that it must be limited to the kind of instrument shown in Fig. 7 of Mr. Bell's patent. Polarizing the armature, then, is *old of itself*.

A polarized armature presents in its employment three different features: it becomes more sensitive; it can be alternately repelled and attracted when placed in front of a single pole magnet; when employed as Siemens employed it, placed between two poles of a horseshoe magnet, the passage of alternately reversed currents draws it first to one side and then to the other, whereas, if it were unmagnetized, it would simply be drawn to one side and kept there,

and would not be caused to vibrate. The discovery and the employment of these principles is *old* in telegraphy. Whatever patentable invention is set forth in this issue consists in the employment and adaptation of some of these different principles to the particular uses set forth.

Mr. Bell did, in fact, select for his purpose, in his first patent, a magnet which was well known in the art. See his letter of July 7, 1875, which describes it (Dodd Record, vol. i, p. 441). He selected this form on account of its strength. Mr. Edison, on the other hand, mounted the free end of his armature between two poles of a horseshoe magnet, exactly as in the Siemens relay, so that the tongue might be drawn alternately to one side or the other as often as the currents were reversed. Mr. Gray's device is essentially the same as that of Mr. Bell. The magnet employed by Gray is essentially a horseshoe magnet. See sheet No. 1 of his application (vol. iii, p. 333). One pole of it is the end of the core C, opposite the centre of the plate. The magnet then extends down through the lamelle A, which forms part of it, up through the piece of metal D, and terminates in a ring *e*, which connects with the diaphragm, and thus a horseshoe magnet is formed, one pole of which is the core of the electro-magnet C, the other pole of which is the diaphragm in front of it. This is not a permanent magnet, but it is kept polarized by a battery current passing through a coil which surrounds the core. Mr. Goodbridge says that an instrument like that shown in application No. 4 was first made and used in the fall or winter of 1877 (vol. iii, p. 371); this was two months after the grant of Bell's patent. Gray's application was filed Jan. 17, 1878. His first instrument which he pretends can possibly meet the issue was the wooden sounding-box magnet receiver, which he says was made and used in December, 1874 (Goodbridge, ans. 60, p. 370). That wooden sounding-box magnet receiver, a drawing of which is found on page 412, does not at all meet the issue, does not have a resonant tube to convey sound from the diaphragm to the listener, does not have a diaphragm; it is merely like the ordinary vibrator, the fixed end of which is secured to one pole of the magnet, as in the case of an ordinary magnetic circuit breaker.

The earliest date they gave for this, however, was December, 1874.

We shall see presently, that even if the character of that work was sufficient, it would not overcome Mr. B.'s dates. The Office, however, has decided that the early work Gray refers to is not sufficient; the form of instrument shown by it was patented to him by his patent 175,971, granted April 11, 1876, on an application filed Jan. 8, 1876. It will be observed that this patent is later than Mr. Bell's; that the application for it was pending at the same time that his was pending, and that neither at that time nor at the present did the examiner find that the instruments presented such points of similarity as to give rise to an interference with that patent. And if this is true of the wooden humming-bird magnet receiver, it is still more true of anything which could have preceded it in Mr. Gray's work. Nor is there any claim of diligence to connect his experiments of 1874 with an instrument first made in December, 1877, and on which the patent was applied for in January, 1878.

Another answer to any attempt on the part of Mr. Gray to antedate this feature in a speaking telephone is found in his caveat. When, in February, 1876, he undertook to describe the utmost of his knowledge on the subject, he did not show the polarized armature. He never attempted to construct an instrument of this kind for the speaking telephone until twenty months after the grant of Mr. Bell's patent. (See Goodridge, nos. 60, p. 370.) The invention consisted, not in the device of polarizing an armature generally, but in the employment of this well-known contrivance in a speaking telephone, and its adaptation to that use. When, therefore, it appears that Mr. Gray described the best instrument he had conceived of for speech on the same day that Mr. Bell's application was filed, and did not refer to this, and never attempted to make a speaking-telephone instrument which included it until Mr. Bell's patent was nearly two years old, it is certain that all that he did before about it must be ranked among abandoned experiments.

Elliott's Case. — Elliott does not pretend to anything on this subject until after the time when he took up the subject of a harmonic multiple telegraph in July or August, 1875. Mr. Bell's instruments were made and used before that.

Mr. Bell's date goes back very far; the apparatus which he described to Dr. Clarence J. Blake in October, 1874, consisted of a

permanent magnet carrying the core on one limb and the reed armature on the other.

The speaking instrument that he described to Dr. Blake (see Bell's deposition, Dowd case, vol. i. pp. 451-453) proposed to replace the multiplicity of the reeds by a diaphragm carrying an electrode, and this was the instrument subsequently made in June, 1876. He may carry back his date of conception on this, therefore, to the disclosure he made to Dr. Blake. If, however, the issue were held to include any polarized reed, as distinguished from an armature mounted on, or forming part of, a diaphragm, a construction which we think would not exhibit anything patentable in view of the state of the art, Mr. Bell's conception goes back much further. His express testimony is, that he devised an acoustic telegraph receiver of that character the winter of 1873-74. He says (Dowd Record, vol. i. p. 451) : —

"*Int. 30.* Did you, during the year 1873, or 1874, devise a receiver in which there was a polarized reed and an electro-magnet? And if so, describe it, and state when you devised it.

Ans. In the winter of 1873-74 I devised a receiver in which the reeds were to be polarized by being attached to the poles of permanent magnets, and they were to be placed opposite the poles of electro-magnets. My method was, to attach one reed to each pole of a permanent horseshoe magnet, the free end of each reed projecting over one pole of a horseshoe electro-magnet. Upon this plan I had one permanent magnet and one electro-magnet for each pair of reeds."

The instrument used as a receiver at the Centennial exhibition, June 25, 1876, and actually handled by Mr. Gray, consisted of a tubular magnet and central core. In this modified horseshoe magnet the upper end of the core forms one pole, and the upper edge of the tube forms the other. A soft iron diaphragm was laid on the top of the tube and thus became a continuation of that limb of the magnet, the ultimate pole of which now became the centre of the disk. Opposite to this was the end of the core which was necessary of the opposite polarity, since the whole was magnetized by the single coil which enclosed the core and filled the tube.

The true answer to this issue, however, seems to us to be that it is intended to be limited, and by the state of the art must be limited to the case of a diaphragm, substantially like that shown in Mr.

Bell's Fig. 7, and does not extend to a simple relay like that shown in his Fig. 5, and in this view Mr. Bell constructed an instrument embodying the invention in June, 1875. Mr. Edison did nothing on the subject till after that. Mr. Gray did nothing of the subject till after that: his first instrument that really meets the issue is the one made in December, 1877, and, considering the nature of the invention and the declarations made in this caveat, it is impossible to pretend that there was any chain of diligence which could connect that construction of December, 1877, with any earlier conception, if there had been one.

Issue 2.—This contains the same element as the first of *Interference L*, with the addition that under this second issue the apparatus is exposed to reversals of current, and thus the advantages of polarization for controlling the direction of movement which are exhibited in the well-known Siemens polarized relay are obtained. If this issue again includes the case of a simple tongue, it is thoroughly anticipated by the apparatus described in the Varley patent of 1870 (near the bottom of page 560, vol. ii. Dowd case). The acoustic receiver there described is in fact Siemens' relay adapted for acoustic purposes, and is the same as that shown in Edison's application. It is operated by reversed currents produced by placing the instrument in the secondary circuit of an induction coil, the primary circuit of which is broken by a circuit breaker. This is exactly the arrangement shown in Edison's application. That arrangement, however, is entirely different from the one shown in Mr. Bell's patent, which does not place the free end of the tongue between two poles of a horseshoe magnet, does not avail itself of the principle which causes the Siemens and Varley and Edison instrument to operate, and does not employ an induction coil. Comparing the Edison and the Bell apparatus, it is clear that they adopt different mechanisms for the purpose of employing different electrical principles. It therefore is not in the employment of this principle that the interference consists. We are not able however to discover, in what it does consist, but we assume that it consists in something shown in Bell's patent.

State of the Parties.—There is nothing in Mr. Edison's work bearing upon even the instrument shown in his application which

antecedes Mr. Bell's instrument of June, 1875, — the same as that of his patent. Nor is there anything in Mr. Gray's work which antedates it. The only thing he refers to is an apparatus, described in Goodridge's sixty-ninth answer, p. 369, and again referred to in his sixty-first answer, p. 370. That instrument, however, does not work by reversed currents. There was no reversal at all of the current. It is true that upon closing the circuit there is what is known as an extra current, which is in a direction opposed to the main currents, and somewhat detracts from the effect due to and intended to be obtained by the interruptions, but they never reverse the current as a whole, and, instead of being desirable, they are injurious in practice. They exhibit an electrical phenomenon which is annoying, and to be got rid of by every possible means, not one which the instrument is adapted by its construction to utilize. Moreover, even Mr. Goodridge says that he cannot pretend that anything done as stated in these answers could meet this issue, except upon the assumption that the black-box receiver was held in a position entirely different from that stated in the patent, to wit, by raising one edge of it on one pole of the magnet, and propping the other up by interposing a piece of a match or slip of wood between the plate and the other spool. Now, if you have this state of facts, and in such an accidental or experimental use of that instrument as occasionally occurred a piece of match was put in to prop up a part of it, and did not occur at any other time, and that three months after that, Mr. Gray patented that instrument and did not refer to any such propping device, but, in his description, expressly excluded it, it is quite certain that all he did, by any construction different from that shown in the patent, must pass into the category of abandoned experiments, if they rose even to the dignity of experiments at the outset.

Mr. Goodridge, in his sixty-second answer, intimates that the instrument Exhibit Gray's Glass Resonator, shown on page 419, would meet the issue. It does not in any way. That does not show a polarized armature. Mr. Goodridge, in his cross examination, pages 284, 385, undertook to say that the strained strip of steel in that glass resonator instrument was polarized in the sense of the issue, but he had to confess that such *quasi* polarity, as it had, was merely the tem-

primary or residual magnetism which every armature always and necessarily acquires when it is used in connection with an electro-magnet placed near enough to it to operate upon it. But he previously had to acknowledge (cross-ans. 144, p. 386) that, according to the perfectly established acceptation of the words, this residual magnetism would not entitle the armature to be called a polarized armature. "Polarized armature" is a phrase expressly and distinctly appropriated to an armature which is permanently magnetized by some means other than the mere presence of the magnet which is to attract it. An armature so polarized is shown in the conflicting application. The glass resonator does not involve such an armature.

Neither contestant has proved a construction or a conception before the construction by Mr. Bell, in June, 1875, of instruments like his patent. Neither contestant constructed a speaking telephone with this feature until the middle or latter part of 1877, when Mr. Bell's patent was eighteen months old.

Priority should be awarded to Bell, the petitioner.

This concludes all the issues in which Mr. Bell is concerned.

MISCELLANEOUS MATTERS.

Some comments on the part of Irwin, on an apparatus of Gray's, remain to be noticed.

For reasons which are not very apparent, Professor Marton, called for Irwin and Voelker, undertook in his deposition, beginning on p. 265, to so twist and pervert the meaning of the word "undulatory" as to apply it to something which he found in one of Mr. Gray's circuit breakers. We suppose that the intention is to argue that one feature of an electric current found in every circuit-breaking apparatus, and to which he misapplies the word "undulatory," anticipates an entirely different feature to which Mr. Bell arbitrarily but improperly applied that word. The current which Mr. Bell employs for the transmission of speech is a current which is never broken, which continually varies, and the variations of which correspond to the movements of the air, due to the spoken words by which they are produced. These are its three qualifications: they

are all essential for its purpose, and his patent is for the employment of that current so varied for the transmission of speech. "Undulatory" may or may not be the best word to express one or two of these characteristics, but this word had no special meaning as applied to currents before Mr. Bell's patent, and he gave it a meaning. Now comes Professor Marton and says that when Mr. Gray used his circuit breaker he did interrupt the current, and he did not give to it the form which corresponds to vibrations produced by spoken words which went into the instrument. But he says that the current going through that instrument is not absolutely chopped off square, so to speak, when the circuit is opened or closed, but that when the contact is made it requires some time, excessively short, it is true, to reach its maximum, and when the circuit is broken it does not absolutely and instantaneously stop, but that, according to the well-known laws of electricity, what are called extra currents are generated by the stoppage of the flowing of the current itself, and this slightly modifies the current in the wire, so that it does not absolutely start square and stop square.

He attempts to show this by some lines on page 266 of his deposition. But he had to retreat from this on cross examination. On page 278 he said in terms that he had not found in any of Mr. Gray's transmitters any contrivance by which the articulate current of Mr. Bell could be produced. He said, further, that it was not possible to produce that current in these instruments. In his nineteenth answer he said that the effect of these extra currents in rounding off was due to the size and character of the circuit, the number of magnets included in it and its other physical characteristics, so that these disturbances in the current proceeded from the physical imperfections of the circuit and not from the will of the operator. He further said that this fact that the currents were slightly rounded, though completely broken, when the circuit breaker was employed, was one which was well known to exist in all circuit breakers and was a part of their character (p. 279).

BRIEF FOR FRANCIS BLAKE.

INTERFERENCE NO. 1.

This is an entirely distinct interference from the interferences A to L, and Mr. Bell is not a party to it; it but for reasons stated in the Record, vol. iii. p. 1, the cases are set for the hearing at the same time; the same volumes of record apply to this which apply to interferences A to L.

The issue is:—

"A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movement of the diaphragm." (Blake's claim.)

The interference was declared Aug. 14, 1879.

The parties are:—

Thomas A. Edison, application No. 141, July 20, 1877.

Francis Blake, application May 10, 1879, by division of application of Jan. 9, 1879.

John H. Trevis, application May 24, 1879.

William L. Voelker, application Sept. 26, 1879.

On page 76, *supra*, we have described the articulating microphone. In its simplest form it consists of a vibratory plate capable of being moved by the voice and carrying one electrode in a circuit. In contact with this is another electrode, held upon a support which is so far independent of the diaphragm that this second electrode substantially is not moved by the motion of the diaphragm, except through the push or pull given to it by its contact with the first electrode carried on the diaphragm.

Inasmuch as the motion of the diaphragm sets upon it through its point of contact, every movement or change of position of the diaphragm which causes a transfer of force from the diaphragm to the back electrode, produces at the point of contact a pressure which varies with and corresponds to the amount of force or motion which the vibrating diaphragm brings to bear upon the back electrode.

These variations of pressure produce corresponding variations in the electrical conductivity of the contact. As the pressure increases, the current passes more freely; as the pressure diminishes, the current experiences greater electrical resistance, and, according to Ohm's law (p. 53, *supra*), it is correspondingly enfeebled. In this way the vibratory motion of the diaphragm taken up from the sound waves serves to vary the resistance of the circuit. The earliest form of microphone provided with contact points is shown in Mr. Berliner's application, referred to in the preceding set of interferences. In that form the back electrode is rigidly supported in a frame. It is obvious that in that instrument a large range of motion in the diaphragm will make it part contact with the back electrode, and thus absolutely destroy the capacity of the instrument for articulate speech. But it is well known that with the rigidly supported back electrode the diaphragm can be so constructed and arranged that under the ordinary influences of the voice its range of motion will be so slight as to vary the pressure without breaking contact, and thus with such an instrument can serve as a speaking-telephone transmitter. There are various ways of arranging the diaphragm for this purpose in combination with a rigidly held electrode, which need not be here considered, because they are not involved in these interferences.

This was the state of the art upon which the invention set forth in the issue arose, and upon which it is an improvement. The improvement stated in this issue consists in modifying an articulating microphone in which the vibrations of the plate vary the contact pressure without breaking the circuit, by carrying the back electrode on a spring which shall constantly press the two electrodes together, give the desired normal pressure between the two, yield to the movements of the diaphragm, and thus preserve the contact. This enables a diaphragm to be used with a greater range of motion, without the frequent breaks of contact which would otherwise occur in the operation of the articulating microphone without some device to prevent them. It is not the only way to prevent breaks; as already stated, the combination of a rigid point with a diaphragm made very thick, or otherwise contrived to have a very small range of motion, or, the combination of a mass of soft carbon with the diaphragm having a very small range of motion, obviates the difficulty and makes an ex-

cellent practical instrument. This is the character of the instrument commonly known as the Edison carbon telephone, of which probably not less than 20,000 are in use, and which is shown in Edison's Record, vol. ii, p. 541. We are concerned in this issue, however, with the other way of improving the instrument, to wit, preserving the continuity by mounting the electrode on a spring, which shall, not merely when the instrument is at rest, but constantly, when in operation, press the two electrodes together and yield to the movement of the diaphragm.

There is one other advantage in the spring-carried electrode when an ordinary thin diaphragm is used, and that is, that its ability to yield will prevent it from interfering with the ready and easy vibration of the diaphragm, while a solid abutment, against which the diaphragm struck, would, if its vibrations had much range, seriously impede their character.

It will be observed however that the feature of this issue and the most important feature of this issue is, that the spring is to be one which "constantly presses" the two electrodes together. It is therefore not met by any apparatus which does not possess this *continuity of contact*.

At the time the invention described in the issue was made, it was not new to make an intermittent contact between a vibrator and a stop for the purpose of passing an electrical current through them when they were in contact. Vibrating circuit breakers, which have been known twenty years, consist in a reed which moves to and fro and at one or both extremities of its path comes in contact with a fixed point and establishes the circuit. Such an instrument is shown as the transmitter in Varley's harmonic-telegraph patent of 1870 (Dawd Record, vol. ii, pp. 552). But the contact of a vibrating reed with a solid body somewhat interfered with the correctness of its vibration; it is practically impossible to vibrate a reed continuously, so that each excursion shall be of exactly the same length, and therefore, sometimes, it will strike against the point harder than it does at other times (Edison, vol. i, p. 28).

The next improvement, therefore, in this class of vibrating reed circuit closer was to carry the contact point on a yielding spring, so that when the blow was unusually heavy or the excursions unusually large the point would yield to the movement of the vibrator, and

after it had been pushed aside, would again return to its desirable normal position. Devices of this kind were invented at an early day by Mr. Edison, and are shown in a very finished form in his patent 75, filed Jan. 14, 1876, and in the various patents which shortly after issued upon these inventions (e. g. p. 152, *supra*). The Reis telephone, also, in its various forms, exhibited one electrode which moved to and fro in a vibratory manner, and at the end of each vibration came in contact with another electrode, and thus alternately made and broke the circuit. In this instrument Reis carried the back electrode on a spring or some kind of yielding device which took the place of a spring. The first form used by him and shown in Record, vol. iii, p. 245, carried the back electrode on a strip of metal, which was yielding because it is described as a "thin strip of metal." It, however, as we have already shown, was so constructed and arranged that it necessarily broke the circuit at each vibration.

In another form of Reis, shown on page 251, vol. iii., the back electrode was allowed to move freely, but returned in its normal position when the instrument was at rest, by gravity, so that however much it might be knocked aside it would return to its proper place, while it was made so light as not to interfere with the movements of the diaphragm. This, however, as we have already shown, is a circuit breaker. In the instrument of Reis, figured on page 261 (the cone form), the connection was established by means of a very light lever, held to its normal position by a light spring. This again, when knocked aside, would return to its normal position, as we have already described in considering the Reis instrument (pp. 73-96, *supra*).

The distinction between that and the articulating microphone is, that one is so constructed and arranged as to break the circuit at each vibration, while the other is so constructed and arranged as to preserve the circuit unbroken under the influence of ordinary speech. This feature of constant contact is aided and secured by means of the *constant* pressure of the electrodes together by the spring, and this feature is prominent in the issue. It is to this that it owes its patentability.

VOXALAN'S CLASS.—The interference was declared Aug. 14, 1879, and Irwin was notified of it. He thereupon procured his

employed to make the interfering application filed Sept. 26, 1879, by the same solicitor who represented Irvin.

The application says:—

"My invention relates to the telephone as above described, and consists in a non-sensitive electrode, maintained in contact with a sensitive electrode, with an elastic pressure, whereby said non-sensitive electrode may respond to the vibrations of the sensitive electrode, with variable pressure and unbroken contact."

The described operation is:—

"The electric current passing between the electrodes, as set forth, will be transformed into a series of undulations, without *interesting disruptions*, and said articulate sound waves will be thereby conveyed to and reproduced by the receiver. The structure of the parts above described may be greatly varied without introducing any *embodiment* of a sensitive electrode on one side, and electrode in contact therewith, with an elastic pressure capable of corresponding vibrations, and the effect set forth will be an embodiment of my invention."

"Having described my invention, what I claim as new is:—

"Is a telephone a spring forming or carrying one electrode of the circuit, and *constantly pressing the same against the other electrode*, and the sensitive diaphragm wherein it is carried, whereby the required initial pressure between said electrodes is maintained, and they yield to the movements of the diaphragm."

It is obvious that those who drew and presented this application understood that the *constant pressure*, the *constant contact*, and the *uninterrupted current* were the essential things, both in the issue and for the production of speech. This their application alleged, and if they do not prove this they do not prove a case.

Our full discussion of this is on pp. 141-153, *supra*.

Voeikar's assertion is, that he made this invention and embodied it in an instrument about May, 1876 (Voeikar's Exhibit A). If it were true that what he then did involved the invention in controversy and also at that time amounted to a completed invention, including the construction of a practical working instrument, undoubtedly he has the earliest date; or if what he did then involved a clear and distinct conception of the invention as stated in the issue, and was followed up with due diligence till the actual construction of a working instrument out of his own idea contained in that conception, and which would practically transmit conversation,

so that he could claim the date of May, 1876, he is the earliest inventor; but not otherwise.

We have to consider, then, in his case, the character of his ideas, the character of his work and his course of conduct since.

Character of his Ideas and Work.—He begins his statement of his work of 1876 by saying that he had observed how a Morse key broke the circuit each time it was depressed. He then concluded that if a key could be made to open and close the circuit at each vibration produced by the voice itself, the voice itself would become operative to produce a sound at a distant station. (See his testimony quoted on p. 129, *supra*.)

It was far that purpose and to carry out that conception that he made the instruments and did the work of 1876 (pp. 129, *supra*). It is perfectly clear that that conception was the conception of a *delta circuit breaker*, and that he was not far enough advanced, even in the knowledge of the requisites for the transmission of speech and in the knowledge of what constituted "quality," to know that such an apparatus, which repeatedly broke the circuit at each vibration, was absolutely incapable of transmitting speech, although it might produce some sound under the influence of spoken words. None from the beginning to the end of his deposition he does not intimate in any way that a different conception from that which he expressly says he started with ever entered into his mind.

This is the more significant because he perfectly understood and clearly set forth in his specification the distinction between an instrument which breaks the circuit at each vibration under the influence of the voice, and an instrument which varied the contact pressure without ever breaking the circuit (pp. 127, 149, *supra*), and in his deposition carefully distinguishing between his present knowledge and his former knowledge, he nowhere asserts that he ever in 1876 or 1877 conceived the idea of constant contact, which is the basis of his application. See for this, pp. 127-130, 151, *supra*. He has not, therefore, proved that he ever had the conception which is the essential basis of the invention in controversy.

Next, his work was investigated in 1877 and again in 1878, by skilled counsel and experts employed for that purpose by the owner of his application, Mr. Irwin (pp. 134-135, *supra*); and Mr. Irwin himself was a man of scientific attainments. Mr. Irwin made this

investigation because Voelker at that time was in his employ, and Mr. Irwin had arranged with him, if he found any substantial invention in what Voelker had done, to take it up and patent it. Mr. Irwin was himself also at that time engaged in making improvements in telephones, every one of which rested upon the principle of the microphone which it is now said Voelker invented as part of the same work in which he made the spring-contact instrument. The conclusion then arrived at by Mr. Irwin and his learned advisers was that Voelker had made a Reis transmitter. Those gentlemen knew perfectly well that the Reis transmitter was a circuit breaker, because the very description of it which they read for the purpose of investigation so describes it, and is put into the case (p. 136, *supra*).

Mr. Irwin has been called as a witness, but neither he nor any one else has pretended that they failed to understand what a Reis transmitter was, or that they failed to appreciate everything that Voelker had done (p. 137, *supra*). It is perfectly impossible, therefore, for the Office to permit itself at this late day, especially under the circumstances presently to be referred to, to arrive at any different conclusion, or to find in any of the depositions of these same parties now produced, evidence which is as persuasive as the judgment then deliberately formed and consistently acted upon.

No operative instrument ever made by Voelker.—The description given in the evidence for Voelker, of the results produced, the manner in which the contact parts were arranged, and the operation of his only spring instrument A, show conclusively that he had never made, did not know how to make, an apparatus (p. 130, *supra*) which could practically transmit an articulate sentence. He had never transmitted a single articulate sentence by any instrument of his own invention up to the time when he filed his application, which was ten months after Mr. Bakke's instrument had gone into practical use, and when there were ten thousand of them in the hands of the public.

We have already observed that the instrument H, which is the only one produced by Voelker embodying the invention in controversy, was not his invention at all, but was devised by Mr. Irwin in October or November, 1877, after Edison's application.

Diligence.—But it is certain that Voelker had never made a practical instrument by which conversation was carried on before he filed his application. Even if the conception and experimental work of 1876 or 1877 could amount to a conception of the invention in controversy in the sense of the law, he did not follow it up with any diligence, and it did not result in an operative instrument. He made one spring contact instrument, he says, in May, 1876. It was "A," a model of the very rudest description. He never attempted to make another spring contact until he made one according to Mr. Irwin's ideas and inventions, about December, 1877. He never made a second one according to his own ideas. The testimony is that the first instrument (Exhibit A) was used for a few experiments. It then was not employed again even experimentally; was packed in a trunk with a lot of other models relating to all sorts of subjects, and remained there until August, 1879 (p. 157, *supra*).

The instrument H, which is not at all Voelker's instrument, as we have already stated (pp. 150, 151, *supra*), was made about December, 1877, or January, 1878; probably used two or three times, and, so far as their evidence can be relied on, broken up and the parts collected and put together for the purpose of being used as evidence in this case (p. pp. 138, 139, *supra*). Moreover, that instrument was not a reduction to practice by Voelker. It is true he was the workman who made it, but he made it as embodying Irwin's ideas, and an exactly similar instrument has been put in evidence by Irwin, as his invention, made at that time as his embodiment of his own invention. See a consideration of these, pp. 136, 140, 150, *supra*.

For the delay between his alleged invention and his appearance at the Office, or the production of an operative instrument, no excuse is presented. Poverty is talked of, but Irwin was always ready to supply money if he could find anything in the work which was novel or useful. He and his advisers found that Voelker had merely reinvented the Reis transmitter. There is not a suggestion in the testimony that Voelker thought they failed to understand or appreciate his work.

Since the beginning of 1878 he has been constantly in Irwin's employ as a skilled assistant, and presumably on good salary.

There is no suggestion that he had any special expenses or difficulties during that time; he was a good mechanic, able to make in half a day just such a model as he has filed. It is said that Irwin did not allow any of his assistants to experiment on their own account; but that course is destructive of the claim now asserted, that Voelker already possessed a perfectly operative speaking telephone.

The truth is that there is only one thing which is consistent with their conduct, and that is, that he had not made an invention nor constructed an instrument that would talk. And so they thought till they saw and coveted the Blake transmitter.

In considering the question of diligence, moreover, it must be remembered that the instrument was of easy and cheap construction; that from the fall of 1876 to the time when Voelker filed his application, three years later, there was no invention which attracted such great attention as the telephone, nor in which improvements were more readily accepted and made much of. Patents for improvements were coming out every week during the last half of that time. The instruments which embodied the inventions now claimed by him were in extensive and growing use. No case can be conceived which, as matter of law, called for greater activity to constitute "reasonable diligence," or in which delay so strongly proves that the claimant had nothing worth producing.

The delay of Irwin, Voelker's assignees, makes the same as 'delay of the alleged inventor himself (Duckworth v. Crompton, Com'n's Dec. 1876, p. 42).

Voelker's Instrument was not an Improvement.—The invention set forth in this issue is an improvement of mechanical construction in the articulating microphone, and it consists in substituting the spring-carried electrode for the rigid electrode. Now that improvement is neither made nor embodied unless the claimant shows that he has constructed an instrument with a spring-carried electrode, which is practically an improvement over the rigidly held electrode. Mr. Voelker's own testimony is explicit, that he first made the rigidly held electrode instrument, and that he afterwards, in May, 1876, constructed one which he says had the spring-carried electrode; that upon repeated trials he found it was not so good as the rigid point one (p. 143, *supra*), and while he made three or

four more of the rigid point instruments he never made another with the spring-carried electrode. It is clear, therefore, that he cannot pretend that he has made an improvement in microphones even if he invented a microphone when the instrument in which he introduced his alleged improvement was found to be inferior to the previous one; it was discarded and the previous style employed and reproduced, because he found that the second was not an improvement.

Finally, it must be remembered that Irwin, perfectly familiar with Voelker's work (p. 135, *supra*), filed an application May 24, 1879, in which he swore that he was the first inventor of this feature. It was only after Irwin had learned that one of the interfering applications (Edison's No. 141) was filed long before he began his own work that he caused Voelker to search his box and bring out this claim and this old instrument (p. 157, *supra*).

In Putnam v. Hollander, quoted, p. 266, *supra*, Judge Blatchford said:—

"The world derived no benefit from what he did. The recollection of it was stimulated by the success of De Gullfeldt's invention. But for that, Otto's structure would have still been replying in the old trunk beneath the stairs forgotten and worthless."

These tardy resuscitations after the success of another are always fatal to a claim.

Voelker's case fails entirely therefore for the following reasons:—

He never conceived of an invention which had the elements which are set forth in the issue as essential, and which are necessary to the transmission of speech.

He never made a sufficient instrument.

He did not exhibit reasonable "diligence."

He abandoned his uncompleted work, and reverted to it only when Blake's instrument had long been successful, and more than 10,000 of these were in the hands of the public.

His whole history is inconsistent with the facts which so tardy a claimant of so important and instantly accepted an invention must prove to make out his case.

Irwin's Case.—For a full discussion of it see pp. 155-159, *supra*. Mr. Irwin's claim is that he made the invention in controversy in

October, 1877, by taking one of Voelker's right-contact instruments and applying a spring to it.

That, however, was a mere temporary experiment, and the spring was taken off after a few hours' trial and the instrument broken to pieces. Its parts, without the spring, were gathered and put together to be introduced in evidence as part of Voelker's case. We have already sufficiently shown that all Mr. Irwin's work branched off into a different class of transmitter, which did not meet this issue (pp. 155, 156, *supra*); that the one or two rude, experimental models, which could be thought to embody this invention were thrown aside, and that his exertions were entirely devoted to another type of instrument, on which he has taken out many patents. He was a professional inventor and patentee, employing many solicitors, and in the constant habit of taking out patents. He did not show, in any application to the Office, or make any claim as the feature in controversy,—a spring, which presses the two electrodes together,—until his application, May 24, 1879, when he became aware of the great success which Mr. Blake had achieved in this class of instruments. Irwin then proposed to endeavor to capture the Blake transmitter. Whatever Mr. Irwin may have conceived of in October, 1877, or early in 1878, it is certain that he did not get beyond one or two experimental models in which the spring pressed the electrodes together. These, according to his testimony, were thrown aside, broken up, never reproduced until after the Blake transmitter became known, and only brought together again recently to be used as evidence in this case. He gave up that whole type of instruments for another class. It is perfectly clear, therefore, that he is, like Mr. Voelker, in the category of those who threw aside their experiments in this line as fruitless, and certainly he did not follow it up with the diligence the law requires, to enable him to date back to his early conception, even if that early conception were not of itself abandoned. The language of Judge Blatchford, in the case of Putnam v. Hollander, 19 O. G. p. 1425, quoted on p. 266, *supra*, describes their conduct with reference to this invention.

Mr. Irwin assumed this kind of instrument, if he had ever really done anything with it, not from any promptings of his own mind, but only when and because he found it a great practical commercial

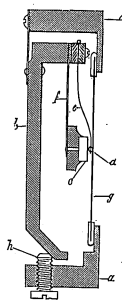
success, as Mr. Blake, an independent and original inventor, had arranged and constructed it and laid it before the public. We have already sufficiently shown that in August, 1872, Mr. Irwin's said application was thrown into this interference No. 1, and by the declaration of interference he was informed that one of the contending parties was Mr. Edison, whose application was filed in July, 1877, that is, three months before Mr. Irwin began to turn his attention to the subject, so that he could not prevail against Edison. He, therefore, caused Mr. Voelker, his employé, to rummage in his trunk among his old forgotten models to see whether there something could not be found which might be reconstituted and sworn into life to answer his purposes. The consequence of that was that the instrument which he and his advisers had once condemned as neither novel nor useful was brought forward by them and put into an application filed Sept. 26, 1879, as an anticipation of the Blake transmitter and of Edison's application of 1877.

Such a scheme itself carries its own condemnation. If, therefore, the case rests between Blake, Irwin and Voelker, the Office must find that Voelker had never made the invention, as a matter of intellectual conception; and that, therefore, he never reduced it to practice; that the early work which he relies on did not go beyond experiment, was abandoned, or not followed up with sufficient diligence to enable him to obtain a patent on it. That Irwin's early work ranks merely as an abandoned experiment, and that, if not absolutely abandoned, it was still a mere experiment with a rude model in his own laboratory, never followed up with the diligence which would enable him to date back to it.

Mr. Blake's Case.—It is, perhaps, needless for Mr. Blake to contend with Mr. Edison on this issue. Mr. Edison's application speaks for itself, and it cannot be denied that his transmitter, with the receiver there shown, or any other known in July, 1877, could practically transmit speech as an articulating microphone with a spring-carried electrode. We have in other controversies asserted that the great practical merits of the Blake instrument are due to modifications introduced by Mr. Blake and not found in the work of any other inventor. This issue, however, presents a feature which is recognized as one of the important characteristics of the instrument.

This interference has its origin in the following history: Mr.

Francis Blake was an officer in the United States Coast Survey for many years; he had been charged with the clerical determination of longitudes; he had thus become familiar with electrical apparatus and with instruments of precision. In the summer of 1878 he made the inventions which are embodied in the now well-known Blake transmitter. In October he constructed his instruments for commercial use in connection with the Bell Telephone Company, and early in November, 1878, the instruments were actually put into commercial use in New York and elsewhere. Their practical merits cause them to be received with great favor. They went into use very rapidly, and by the latter part of May, 1879, nearly five thousand were in commercial use in different parts of the country. This is particularly stated in the deposition of Brown, foreman of the factory where they were made (vol. iii. p. 554), and Mr. Watson, superintendent of the Bell Telephone Company (vol. iii. p. 601).



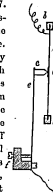
The cut in the margin shows the manner in which the diaphragm and electrode are arranged. It is a full-sized section of the instrument in ordinary use, and hardly differs, even in its details, from the instruments in the hands of the public in the late fall of 1878 and beginning of 1879. In this drawing *g* is the diaphragm, the special supporting parts of which are removed from the drawing for convenience; *d* is an electrode, which is either soldered to the diaphragm or carried on the light spring *e* so that it directly partakes of its motion; *c* is the back electrode, which is supported on the spring *f*, so strained as to press constantly toward the diaphragm and preserve the contact. The other parts of the apparatus exhibit special features which are not involved in this interference.

Mr. Blake's date of invention of this is fully set forth in his own deposition, and was in July, 1878 (vol. iii. p. 568). Operative instruments embodying the spring and the weight to carry the back electrode were then made and used. There is, of course, no doubt about the practical utility of this contrivance, for more than 40,000 instruments exactly corresponding with his model in these particulars are in practical use, and his model itself was an actual working instrument taken out of the stock at the factory.

Mr. Edison's Case. — Mr. Edison's instrument is shown in his interfering application, 141 filed July 20, 1877.

The drawing in the margin is a diagram to illustrate so much of the instrument shown in the application as concerns our present purpose. *a* is the diaphragm, supported at its edges by the frame *b b*. The current comes in through the wire shown at the top of the figure, passes through the metal diaphragm to the platinum contact piece *d*, from there passes through the contact to the carbon contact point *e*, thence through the spring *e'* to the other wire, and off to line. As the diaphragm *a* vibrates to and fro under the influence of sound waves it moves *f* against the electrode *c*, carried on the spring *e*, and first pushes it in one direction, and as it recedes the stress of the spring *e* constantly pressing *e* against the other electrode, causes the electrode *c* to follow up the diaphragm and preserve contact.

As the motion of the back electrode *c* is derived from the diaphragm, the force which imparts it manifests itself as pressure at the point of contact, and as the force or motion varies this pressure and the consequent electric conductivity vary, and the current is correspondingly increased and diminished. The apparatus is also provided with the adjusting screw *f*, which serves to give the suitable normal pressure to the instrument. It will be observed that this adjustment causes the spring to press the electrode *c* against the electrode *d* and thus preserve the contact.



Mr. Edison claims that he made this invention some time before he filed his application, but that is not very material, because no contestant did any work in that interval, and for the purpose of our present inquiry he may stand on the application itself, the date of which is July 30, 1877.

No one has protested that this instrument, shown and claimed in the application as a speaking telephone, and described as operating by variations of pressure, is not an operative instrument, although experts.

As Mr. Edison, however, did make the invention in issue and embody it in an application duly filed in the Office, which he has continually pressed for patent, we suppose it must be taken that, as against those who invented it after he filed that application, he has the prior right, and that that right is not affected by the fact that among several types of instruments which he invented and described to the Patent Office at that time he preferred to expend his energies in making further improvements on the one type rather than the other.

Mr. Edison has, in a spirit which does not commend itself to anybody's judgment, sought in one part of the testimony on his behalf, to assail the merits of the Blake instrument, and assert that the soft carbon instrument, as he developed it, with a rightly held electrode and soft carbon, is the better of the two. Unsubstantiated the soft carbon instrument is a good practical instrument, but it has some disadvantages, and one of them is, that the tips have to be put absolutely into the mouthpiece, which is disagreeable, and it is partly on account of the great convenience of the Blake transmitter in this respect that it has had such great success; for even Mr. Johnson, who nowadays can see no merit in anything which does not come from Mr. Edison alone, says (Edison's Record, vol. ii. p. 378), that although in his opinion the Blake is an inferior instrument, still the eleven obstinate jurymen who constitute the public are so obtuse to the merits of the instrument his friend spent so much labor on, that they will persist in calling for the Blake. He testifies (vol. ii. p. 378) :—

"*Int. 5.* If instruments of the general character of the Blake transmitter, and instruments such as Edison's carbon telephone, were

presented to the public, which would usually be selected or preferred by customers?

Ans. "The Blake or similar microphone arrangement." . . .

Some other witnesses were called in this petty quarrel of personal jealousy, but the character of the questions asked and answers given amount to a confession that the pretences put forward were untrue. See Edison's Record, vol. ii. pp. 397, 401, 406.

Respectfully submitted by

CHAUNCEY SMITH,

J. J. STORROW,

for Francis Blake.

BOSTON, October, 1881.

Telephone Interferences [Volume 5]

Miscellaneous Interferences

The three briefs for Edison and the decision of the Examiners-in-Chief in the appeal of Cases A, B, C, D, E, F, G, I, J, L, and No. 1 have been filmed.

Edison v. Men

In the United States Patent Office.

ON APPEAL BEFORE THE HONORABLE COMMISSIONER IN
IN PEERSON.

TELEPHONE INTERFERENCES.

CASE No. 1.

PRESENT PARTIES:

T. A. EDISON, W. L. VOELKER.

Brief for Thomas A. Edison.

The parties at the hearing before the examiner of
interferences were

T. A. EDISON, application filed July 20, 1877.

FRANCIS BLAKE, application filed Jan. 3, 1879.

JOHN H. IRWIN, application filed May 24, 1879.

W. L. VOELKER, application filed Sept. 26, 1879.

The examiner of interferences awarded priority to
Edison, and appeals were taken by Irwin and Voelker.
Blake did not appeal.

The Board of Examiners also have awarded priority
to Edison, and Voelker has again appealed. Irwin has
not appealed.

The present contest, therefore, is between Edison
and Voelker.

The issue is—

A spring forming or carrying one electrode of a tele-
phone, and constantly pressing against the other elec-

trade and diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm.

At the hearing before the examiners-in-chief, the counsel for Voelker hid stress upon the fact that "Voelker makes the precise claim which is asked for the issue;" while, as was alleged, "Edison's *claim* do not disclose the issue in controversy."

To one not familiar with the record, this presentation might be misleading. The truth is that the examiner adopted for the issue the precise claim originally made by Blake, who has not appealed from the decision awarding priority to Edison. The interference was declared Aug. 14, 1879, before Voelker filed his application. Voelker was admitted to the interference Nov. 8, 1879; and, in the notices thereupon sent to the other parties, it is set forth that "he claims the invention [already] in controversy."

Voelker made his claim in the precise words of Blake's claim and the precise words of the issue already framed; and it is evident, upon reading Voelker's specification and claims, that his solicitor, when he drew them, had Blake's specification and claim before him.

Moreover, it appears in the record (Vol. III., p. 63) that Irwin, an original party to the interference, has an interest in and the entire control of Voelker's application, and pays the expenses attending it, including the cost of the model. The same solicitor was employed that was employed in the matter of Irwin's application in his own name, and Voelker says Irwin prepared the description that was sent with the model to the solicitor to enable him to prepare the specification. And he adds, "He had more knowledge of such matters than I had."

In respect to the *claim*, therefore, Voelker stands no better than Edison, who, in his specification and drawings, clearly shows and describes a telephone embodying the invention, and, further, makes it evident that he understood the importance of the invention.

A single passage from the specification is sufficient proof of the latter assertion:

"When the springs *c* and *b* are adjusted so as to make contact with the diaphragm equally, no current passes to the line; but, when the diaphragm is vibrated, its movement to one side, say *c*, causes a *greater pressure* upon the plumbago on that spring and a *lesser pressure* on the plumbago on *b*."

In other words, the contact between the diaphragm and each spring is *constantly* maintained.

EDISON'S APPLICATION AND DATE.

Edison's application was filed July 20, 1877. It has been known in these cases as his application, "No. 141." It is his second application for a patent relating to the speaking telephone, his first application (known in these cases as "No. 130"), having been filed April 27, 1877.

In interference No. 1, as against Voelker, Edison may safely rely upon his recent date. His application was filed, as we have said, July 20, 1877. It is admitted by the contestant that the application is for an operative instrument.

Prof. Morton, the expert called by Voelker, states in substance (pp. 373, 374; Inds. 74-80) that he has made a duplicate of Edison's device in case 141, and that it is superior to Voelker's, because it contains carbon in addition to the springs. Morton testifies that issue, case 1, is found in the Edison application 141; and hence Voelker must not be allowed to object either to the issue or to the Edison case 141, as containing that issue.

Morton admits that Edison's devices 141 actually did work, and he gives reasons which actually show superiority in Edison's devices, although at the same time finding fault with the operation as making too much difference in current. This is a merit rather than a defect.

We quote from Prof. Morton's deposition (Vol. III, p. 273):

"*Int. 75.* Have you examined the various forms of the spring exhibits introduced by Thomas A. Edison in his testimony in this case, such as Exhibit 100 11, Exhibit 130 11, Edison Exhibit Spring marked '1877,' and do you understand the same?

"*Ans.* I have examined his exhibits, and believe I understand their properties and intended uses.

"*Int. 76.* Please state whether you find in said Edison application No. 141, or in the Edison exhibits referred to, any advance over the instruments of William L. Voelker, marked Exhibits "A" and "I," so far as the subject matter involved in interference No. 1 is concerned. The subject matter involved in interference No. 1 is: 'A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm.'

"*Ans.* The only advance, or, in fact, difference of any sort in this connection that I find, between this instrument of Edison and those of Voelker referred to is the use of plumbago in one of the electrodes; otherwise, the instruments are identical as regards the points you have mentioned.

"*Int. 77.* In your opinion, is there any advantage or disadvantage due to the use of two springs, one on each side of the diaphragm, as shown in the drawing Fig. 1 of Edison's application, No. 141?

"*Ans.* I think that this is a disadvantage rather than an advantage, because it doubles the number of parts to be kept in adjustment, and exaggerates the effect of slight displacements of the diaphragm or of connected parts, since a motion in either direction not only increases the current in accordance with the change of pressure on that side, but also increases it by a diminution of the opposite current from the other side."

Moreover, the examiner of interferences and the examiners-in-chief, as well as the original examiner, have

found that Edison's application is for a practical instrument and contains the issue.

VOELKER'S APPLICATION AND DATE.

We have seen that Voelker filed his application some weeks after this interference was originally declared, and that he took for his claim the words of the issue and of Blake's claim. His specification shows also that his attorney had an intimate knowledge of Blake's specification as well as of his claim. But the evidence clearly shows that, as late as October, 1877, Voelker had done nothing more than reinvent or reproduce the Reis telephone.

Indeed, when Voelker gave his testimony in these cases, as late as February, 1880, he did not understand the first principle of the speaking-telephone; nor did he know that he could not transmit speech by a make and break circuit. At that late date, referring to his early experiments, he says:

"I know, of course, of the Morse key in transmitting signals; when the key was depressed, an impulse of electricity was sent into the line operating the sonalier armature by the magnetism influenced by its core, and that no matter how many impulses were sent into the line that the effect on the sonalier responded intelligibly to the same given number of clicks of the armature; that the impulses of sound-waves were similar to the depressions made by the finger on the telegraphic key; and, if it were possible to construct a key delicate enough to be manipulated by sound-waves, then the transmission of sound would be realized." (Vol. III, p. 43.)

The only instrument upon which Voelker relies in this interference is Exhibit A, which he says he made in April, 1876. And the following extracts from Voelker's own testimony show that the instrument was not a speaking-telephone. He says:

"This instrument I made in April, 1876—as near as I can remember, in April, 1876. I think the first one I got to experiment with me was the same colored boy, John Henry. I screwed the spring up until the point

bumped the contact piece, and then told him to sing into it, talk, and make various noises alternately, while I went down into the shop to listen. This experiment, in its results, was similar to the former experiment, just getting a few musical tones now and then." (Vol. III, p. 45.)

He thought the trouble lay in the receiver, and made a new receiver and then experimented again, this time with his brother as assistant.

Of this experiment, Voelker himself says:

"The first experiment I think I tried myself by talking into it, my brother listening. After singing and talking to it quite a while, he told me that he could hear the singing very nicely; but, as for talking, he said he did not hear any. * * * Then in a while, he thought I was talking; but he could not make out any clear words." (Vol. III, p. 46.)

Then he thought that the diaphragm had become too moist for further experimenting, and put the instrument away till the next evening, when he again experimented as follows:

"I found the sheepskin rigid, perfectly dry, as it was when I originally made it. After adjusting the point again, I started singing again, while my brother listened at the receiving end. After a while, I came down to hear the result. He told me that the result was about the same as the day before, that he could hear the singing very distinctly, every note coming out clearly. Then I told him to listen very carefully to see if he could hear my words. After a while, I came down to hear the result of that. He told me that he could tell when I was talking, but could not make out anything of words. I tried singing various times, after which I would go down and question him as to what they were. His answers were always correct: he understood the tunes, to know their names. After this, I made him go up and do the singing while I listened. I heard him sing two tunes, after which I ran up and told him to talk, but could not hear anything of articulate sounds coming out of it." (Vol. III, pp. 46, 47.)

Then he altered the instrument, substituting thin sheet brass for the animal membrane; and, in the next experiment, his brother did the singing and he listened, with the following result, as he himself testifies:

"In singing, the tones came out much clearer in musical sounds. I told him to talk to it loud. Sometimes, I thought I could hear a word, but could not distinguish it very clearly." (Vol. III, p. 48.)

He was assisted by several persons, and he says of them:

"Each and every one heard the singing very distinctly; and, when I talked to them, they knew that I was talking, but could not understand very distinctly what I said." (Vol. III, p. 48.)

This last experiment was in April, 1876; and Voelker testifies that the instrument was then completed in its present condition. He says:

"It was complete, as it is now, the latter part of April, 1876." (Vol. III, p. 22.)

Now Voelker's counsel does not contend that—up to this time, April, 1876—Voelker had done anything more than re invent the Reis transmitter.

In his brief before the examiners-in-chief (p. 70), counsel for Voelker says:

"It is not contended that Voelker's instruments in their first form, with skin diaphragms, transmitted articulate speech, although it is obvious that they would have done so with the same experience as was employed in 1879 with the reproduced instruments, said to be like figure 7 of Bell's patent; but the proof for the first transmission of such speech at about the first of May, 1876, by the use of the transmitter exhibit, with the receiver, Exhibit C,* about which experiment Voelker testifies, 'When finished, [that is, receiver C] and placed in circuit, received musical tones very well, and by careful experimenting and patient listening, also words, but not quite so clearly as the music.' (Vol. III, p. 49).

*Exhibit C is a reproduction. (Vol. III, p. 89).

This account of Voelcker's experiments, previous to May, 1876, is therefore only material and important as showing that Voelcker, upon his own testimony, made no marked advance in his experiments in May, 1876. For, after all, he does not convince us that he had a speaking telephone when he says, "This (receiver), when finished and placed in circuit, received musical tones very well; and, by careful experimenting and patient listening, also words, but not *quite so clearly as the music*," any more than he does when he says, "They knew that I was talking, but could not understand *very distinctly* what I said," or "Sometimes I thought I could hear a word, but could not distinguish it *very clearly*."

This account of Voelcker's experiments, previous to May, 1876, and the admission that Voelcker did not transmit speech, serve also to show that a witness by the name of McClelland only imagined he heard "some quotations from Shakspeare," which he testifies he thinks he heard.

We shall refer to this hereafter.

Now is Voelcker's testimony any stronger relatively to the next experiments which took place, with Exhibit D as a receiver, in the latter part of May and in June, 1876. He says:

"The musical tones came out very loud, very clear, and very distinct, now and then words which could not be mistaken" (Vol. III, p. 50).

And it will be observed that Voelcker says that "the results of these experiments [with D as a receiver] were more satisfactory than was the cigar-box receiver [C]," which he testifies, "received musical tones very well, and, by careful experimenting and patient listening, also words, but not quite so clearly as the music."

Testifying in the other interference cases, Voelcker says of the experiment with receiver C:

"The reproduction of musical tones was very fine and very loud, the human voice being heard very well, and occasionally words were very fairly reproduced" (Vol. III, 148).

And this is putting Voelcker's case in the most favor-

able light for himself. Counsel for Voelcker prints in his brief most of these quotations from Voelcker's testimony, and relies upon them; for he gets no support from the testimony of other witnesses as summed up by himself.

We quote from the counsel's brief used before the examiners-in-chief:

"John H. Voelcker says of all these experiments: 'My brother sang into the transmitter, and talked into it also. I listened at the receiver. You could hear the tune of the song he was singing very well, but words I could not hear very well or very distinctly'" (Vol. III, 130).

"The only experiment Browne was present at was of singing; and he says, 'I listened and heard distinctly several times, and I recognized his voice in each time'" (Vol. III, 132).

"Susan Crones, the mother of Voelcker, says, 'He used sometimes after the shop was closed to have them fixed up, and he would call my attention to them to listen to them talk'" (Vol. III, 136).

"Nowell, a hawker in the house, says, 'He used to call down through them,' 'Hallo!' words of that kind; could not make out sentences, but could discern words at that time'" (Vol. III, 132).

"McClelland says that, on one occasion, Voelcker gave him something like a spice-box, 'and I held this box to my ear and heard singing and some quotations from Shakspeare, I think it was.' [Vol. III, 35.] This was before May 3, 1876, as he knows from a sickness commencing at that date" (p. 84).

We submit that these passages introduced in the counsel's brief to support Voelcker's claims show a failure on the part of Voelcker rather than a success.

And the testimony of these witnesses as a whole, make his failure to transmit articulate speech by a spring contact telephone even more conspicuous.

Thus, the passages quoted from John H. Voelcker's testimony relate to experiments, such as they were, with a right contact telephone. (Vol. III, 130). And, since the witness Browne was constantly at Voelcker's

shop during the time under consideration, it is remarkable that he was *sung* to instead of *talked* to, if Voelker had a talking instrument. The whole passage in Browne's testimony is as follows:

"He promised to let me hear this instrument when it was finished, and for that purpose I remained with his brother John one night after the shop was closed. I remained in the shop while William went to the upper stories where he had a wire connected with the machine in the shop. He said that he would *sing* something to me; that, if I listened to the machine in the shop, I would hear him. I listened, and heard distinctly several times, and recognized his voice in each time." (Vol. III, 182.)

If any of Voelker's instruments talked either in 1876 or in 1877, it is remarkable that Browne did not hear them. The testimony shows that he was intimate with Voelker, going to his shop "every other night," and on one occasion lending him a set of drawing instruments to make "No. 5" by. He saw No. 5 made.

He says of No. 1, "I do not remember hearing this instrument, but I remember distinctly having seen it about the shop." And, again of other instruments he says: "I do not remember hearing any of these instruments. I am not certain that I didn't hear them."

By which we may reasonably infer that, if he heard anything, he heard singing and not talking.

Mrs. Cronin, the mother of Voelker, although she says she was asked "to listen to them talk," does not pretend to have heard anything except the music of an organ. "It sounded very pretty," she says, "the piece that was played." (Vol. III, 188 and 56.) And she says that Voelker called her attention to the little spring in Exhibit A, and showed her the little point, and said to her, "Do you see the little *spark*?" "There was *just a tiny little spark in it*," she adds.

Now, in addition to the very damaging testimony quoted by Voelker's counsel (*vide* p. 11), says:

"I don't know that we attempted to talk much;

only to call down, as I have stated before, 'Halloo,' etc."

And this was as late as the summer of 1877, when Voelker was experimenting with a rigid contact instrument (No. 5), of the working of which Newell testifies:

"The results were somewhat better, the music was plainer. I could discern words, but not phrased; nothing like sentences. *I don't know that we attempted to talk much*; only to call down, as I have stated before, 'Halloo.'"

If Exhibit A ever talked in Voelker's hands, Newell ought to have known it. He boarded with Voelker for a year, beginning in the fall of 1876, and assisted him in his experiments. When he went to board with Voelker, Exhibit A and the instrument D were in circuit. He says:

"I recollect the instrument, Exhibit A, very well. He had wires running from the shop to the third story. I remember the instrument, Exhibit D, and hearing music from the sounding-board on it very plainly—I mean the strip of metal on it."

And music was all he heard, except "Halloo!" and words of that kind. They did not attempt to talk much.

McClelland could not have heard the quotations from Shakespeare through a telephone at the time he says he heard them; for counsel for Voelker, as we have seen, says in his brief, which was read before the examiners-in-chief (p. 70): "*The proof gives the first transmission of such articulate speech at or about the first of May, 1876.*" McClelland is positive that he heard the quotation from Shakespeare by Exhibits A and D, in the fall of 1876, or winter of 1876-76 (Vol. III, 83, 84).

But receiver D was not made till the last of May or first of June, 1876 (Voelker, III, 30).

On cross-examination McClelland says that he heard the quotations before he was taken sick, which was on the 3d of May, 1876. This was probably before even Exhibit C was constructed, the first receiver with which it is pretended that spoken words

were received. Voelker, on a direct question as to the date of Exhibit C, testifies that Exhibit C, as near as he can recollect, was made "the beginning of May, 1876." (Vol. III, p. 49, Int. 12.)

But the strongest testimony for Edison and against Voelker is to be found in the deposition of J. H. Irwin, the owner of the Voelker application. Irwin was originally a party to the interference, but could not go back of Edison's reced date, as he did not begin his experiments with the telephone until the fall of 1877. Doubtless, it is this fact that has led him to push Voelker's application. Irwin's own application, which was originally in this interference, was filed May 21, 1879. Voelker's application was filed under Irwin's direction September 26, 1879, several weeks after the interference was declared between Edison, Blake and Irwin.

Now, it appears, both in Voelker's and in Irwin's testimony, that Irwin acquired knowledge of Voelker's experiments in October, 1877.

And, it appears in Irwin's testimony (p. 55) that Irwin had acquired knowledge of Voelker's "telephone research" as early as October, 1877, and that he then took some apparent interest in it. Irwin testifies that, at this time, Voelker took his instruments to Irwin's house, and the two men made a long series of experiments with them in the presence of several of Irwin's friends, and that Irwin then told Voelker that his transmitter was Reiss's transmitter, and that his receiver was old and was also, with the exception of the size of it, a Bell telephone. (Vol. III, 87.)

Irwin also testifies that Voelker fully explained all his experiments and instruments to him, so that he understood them and explained them to his counsel and patent solicitors, Messrs. Thacher & Smith, both experts in such matters, and that these gentlemen concurred with him in the opinion that Voelker had only reproduced the Reis transmitter. (Vol. III, 62, 63.) And it appears that Mr. Smith gave Voelker the same advice or opinion direct.

Moreover, it appears that after October, 1877, Irwin

became the inventor and Voelker a mere workman in his employment, at first temporary, and afterward permanently. Irwin says:

"I first began experimenting on electric telephones October, 1877." (Vol. III, 78.)

And then he testifies to the character of experiments made by himself with the assistance of Voelker, trying, he says, a right point about as many times as the loose or elastic point.

In relation to these experiments, Irwin is asked upon direct examination (p. 100):

"Were these experiments referred to made wholly under your direction and in the carrying out of your ideas, or were they made in furtherance of carrying out the ideas of Mr. Voelker?"

And he answered:

"In furtherance of my ideas and solely under my direction."

And, finally, we find Irwin himself applying for a patent for the invention at issue; and it is not until after he finds his application in this interference that he brings forward Voelker as an original inventor.

Still more than this, Irwin was asked on direct examination (p. 108):

"When, if ever, did you first make and use a telephone having a spring forming or carrying one electrode of the circuit, and constantly pressing against the other electrode and the diaphragm to maintain the desired initial pressure between the electrodes and yield to the movements of the diaphragm?"

And he answered:

"In November, 1877. That is the date of what I called the finished experiment; that is, an inventor's finished experiment."

The date given, it will be observed, is the month following Irwin's first experiments with Voelker as an assistant. Irwin, when he gave this testimony, surely did not regard the crude instruments, which Voelker had brought to him or described to him, as embodying the invention.

Yet more:

Irwin did not file his own application, which was originally in this interference, till nearly two years after the date of Edison's application; and, when asked the reason for this, he replied:

"I thought and now think the invention to be described in my patent, No. 293,266, Oct. 22, 1878, application filed July 20, 1878, oath of invention, June, 1878," &c.

This is in effect a statement by Irwin that in June, 1878, Irwin regarded himself as an original inventor of the subject-matter at issue.

At this late day when the principle upon which the speaking telephone operates, is so clearly understood, no electrician of any reputation will be found venturing to assert that an instrument constructed and arranged to work upon the make and break theory, will transmit articulate speech. And even if such assertions be made, the Patent Office and contestants here, must be bound by the numerous decisions of the Circuit Courts declaring in substance that the speaking telephone works by means of a closed circuit, and that it cannot practically work with a make and break circuit.

And governed by such decisions, and not departing from the theory or rule in this respect, long since adopted in the Patent Office—this issue must be awarded to Edison.

For aforesaid, as against Voelker, Edison may stand upon his application. He has clearly described there a speaking telephone operating by *variations of pressure* in a closed circuit.

On the other hand, the proofs show not only that Voelker did not anticipate Edison's application in reducing the invention to practice, but that he never had the conception of the invention up to the time when he testified. He never even experimented in the right direction. It was always a make and break transmitter he was endeavoring to make, whether the transmitter had rigid points or a spring curled electrode. And in his experiments, which were conducted on

this false theory, all of them, he early lost the chance of even hitting by hazard upon a construction which should successfully embody the present invention. He made but one instrument in which the electrode was carried by a spring, and then he returned to the construction with the rigid point.

LESCUE W. SHREVE,
Atty. for T. A. Edison.

100-1111-819/2

INTERFERENCES ON TELEPHONES

THOMAS A. EDISON,

A. G. BELL,

ELISHA GRAY,

A. E. DOLBEAR,

J. W. McDONOUGH,

G. B. RICHMOND,

W. L. VOELKERS,

J. H. IRWIN,

FRANCIS BLAKE, JR.

Cases A to L and
No. 1.

Brief in Behalf of Thomas A. Edison.

MAY IT PLEASE YOUR HONOR:

The present interferences probably are the most important that have ever come before the Patent Office for consideration.

The difficulties that arise in ordinary interferences are augmented in the present case by

1st. The subtle character of the natural forces that are inseparable from the art that is involved.

2d. By the inaccurate and fanciful official wording of the subject matters of the different issues.

3d. The questions of law that arise, and which in many respects are without any precedents.

In making a decision on these matters I need not suggest that your Honor probably will not be able to satisfy all parties, but certainly there is a broad opening for the display of careful judgment, just discrimination and well considered opinions that will command respect and carry weight, not only in these special matters, but in others that may arise in the Patent Office, so that the present may be controlling decisions that will help to unify the practice of the Patent Office in interference cases.

I propose in the beginning of this argument to direct your Honor's attention to a question of law which is a comparatively new one, and upon the proper decision of which important interests may centre—that is how far a man may branch out in his investigations without losing any right in the device that he makes during his investigations.

The special clause of the law which bears upon this question is Article 4 in Section 4920 of the Revised Statutes, which, among the things that can be proved against validity, is that the patent is for "TRIVIAL WHICH WAS IN FACT INVENTED BY ANOTHER WHO WAS USING REASONABLE DILIGENCE IN ADVANCE AND PERFECTING THE SAME."

The same question which may come up in Court after a patent is granted, should be regarded in determining the issue of a patent, in order that it may be valid.

Sec. 4886, R. S., provides that "Any person who has invented or discovered any new and useful art, machine," &c., may obtain letters patent unless the invention has been in public use or on sale more than two years, or been abandoned.

For the purposes of these interferences it may be admitted that each applicant was an inventor, or has supposed himself to be such, but it will be important to consider whether either applicant allowed the invention he now seeks to patent to be publicly used more than two years before making his application.

It will also be proper to consider whether there is

any act of abandonment by which either inventor forfeited his rights.

It will also be proper to discover whether either of the applicants MADE an invention, as the law contemplates, or whether he was blindly groping his way after something which he never grasped, or in other words, whether certain things were experiments or inventions.

If it is possible at the outset of this matter to come to a reasonably clear understanding of the differences between an *invention* or *discovery* and an *experiment*, and also fully define what is the scope of an *abandonment*, and understand what is reasonable diligence in *adopting* and *perfecting*, the difficulties of this interference will vanish like the morning dew.

To accomplish this task would be to terminate a large proportion of the patent litigations now in existence; and the man who attempted the task will surely meet with an inglorious defeat.

While shrinking from even the consideration of these questions, permit me to present, a few points, in the hope that the task imposed on your Honor may be lightened, for in the consideration of these interferences it will be found a vain task to endeavor to evade a careful examination of each of the foregoing points, and the rendering of a decision touching all or nearly all of them in their application to the questions involved.

In regard to abandonment, the majority of decisions are to the effect that the legal prejudice and inference is *against* any abandonment. The law requires that the patent shall be granted to the inventor or discoverer, unless the invention "IS PROVED TO HAVE BEEN ABANDONED."

At this point a word of caution may not be amiss: Secs. 4886 and 4920, R. S., are in perfect harmony. A man cannot abandon an experiment, he must have made an *invention*, must have gone beyond experiment; an abandoned experiment is a misnomer; the law only speaks of an abandoned invention. It

presumes a man must have made or invented something new or useful before he has anything to give away or to abandon; and Sec. 4920 makes the matter much more clear by defining the only recognized character of abandonment, by saying (that the abandonment must be to the public.

From these premises I conclude:

1st. That abandonment is only a thing to be considered as between the public and an actual inventor or discoverer.

2d. That there must be the most full power of the abandonment, and not an inferential abandonment.

3d. That an invention or discovery must have actually been made before it can be given away or abandoned.

The numerous decisions on this point all favor this construction of the statute, as will be apparent from the following authorities:

Non forbearance to apply for a patent during the progress of experiments, and until the party has perfected his invention, and tested its value by actual practice, affords no just grounds for any presumption of an abandonment. *Agawam Co. vs. Jordan*, 7 Wall, 583; *Seval vs. Jones*, 6 Fish., 343; S. C., 3 O. G., 630; *Locomotive Truck Co. vs. R. E. Co.*, 6 O. G., 927; S. C., 31 Leg. Int., 32; 1 W. N., 16.

The burden of proof to show an abandonment is on the defendant. *Hoffheins vs. Brandt*, 3 Fish., 218.

Those who rely upon the ground that a party has by abandonment forfeited a legal right to secure to him in the form of law for the purpose of defeating his enjoyment of that right, must make out the point clearly and satisfactorily beyond any reasonable doubt or hesitation, because the law does not favor an abandonment, and throws upon the party who seeks to obtain the benefit of a forfeiture the burden of proving it beyond all reasonable question. *Seymour vs. McCormick*, 2 Blatch., 240; S. C., 16

How., 480; *Pitts vs. Hall*, 2 Blatch., 229; *Wyeth vs. Stone*, 1 Story, 273; *American Leather Co. vs. American Tool Co.*, 4 Fish., 284; *McMillin vs. Barclay*, 5 Fish., 189; S. C., 4 Brews., 274; *Sewall vs. Jones*, 6 Fish., 343; S. C., 3 O. G., 630; *Birdsell vs. McDonald*, 6 O. G., 682; *Hovey vs. Henry*, 3 West. L. J., 155.

Abandonment means a general abandonment to the public. It is a dedication to the public, a giving up of the claim to a monopoly in the invention.

American Leather Co. vs. American Tool Co., 4 Fish., 284.

Abandonment must result from the intention of the patentee expressly declared or indicated by his acts.

McMillin vs. Barclay, 5 Fish., 187; S. C., 4 Brews., 275.

A party cannot be held accountable for delays in the Patent Office, and an abandonment will not be inferred therefrom. *The law looks with indulgence upon the delays which arise from the circumstances of the party who may make an invention, and it is only when the invention is intentionally abandoned* "that the law declares that he shall not be protected in his invention."

Sayles vs. Railroad Co., 2 Fish., 629; S. C., 1 Bliss, 468.

Ryan vs. Goodwin, 3 Sumn., 614.

Root vs. Ball, 4 McLean, 177.

Rich vs. Lippincott, 2 Fish., 1.

McMillin vs. Barclay, 5 Fish., 189; S. C., 4 Brews., 275.

The mere fact of making or selling an improvement or invention, or of putting it into public use at any time within two years before the application for a patent, is not of itself an abandonment of the invention to the public. Something more must be done within the two years.

There must be some acts of the inventor indicating an intention on his part to devote his improve-

ment to the public in general, in order to authorize the conclusion that he has so abandoned it. There must be a design to devote the invention to the public at large as a gratuity, and without receiving a consideration for its bestowal.

Seymour vs. McCormick, 2 Blach., 240.
8 Ct. 16 How., 480.
Pitts vs. Hall, 2 Blach., 229.

I am well aware that the term "*abandoned experiment*" is often used in decisions that have been regarded as carrying great weight, but a careful examination of these will show that the expression refers to experiments that are not prosecuted or continued to any result. The use of the term is not finely chosen. The words of the law are few, concise, and such as cannot be misunderstood, and to speak of experiments as not prosecuted, is more correct than to call them abandoned; upon examination of standard dictionaries it will be found that the meaning of this word abandoned has become sadly mixed, but the general meaning is to wholly give up something, as a captain abandons his vessel, a husband abandons his wife, &c. Now, unless the captain had a vessel he could not abandon her; a bachelor could not abandon a wife, because he never had one. So an experimenter cannot abandon an invention, because he has never made an invention; he can cease to experiment and not prosecute the same, and hence for the sake of greater clearness, I contend that it is more proper to speak of an experiment as not prosecuted, rather than to speak of an experiment as abandoned, because the law using the term abandoned does not use it in the sense in which it would be applied when speaking of an experiment, the law contemplates that an invention must have been made before it can be abandoned, the same way that a vessel must exist before the captain can abandon it, but in the case of an experiment there is legally nothing in existence. The law does not protect an experiment in any respect;

the law does not protect anything that is not both new and useful; it does not say new or useful. A man may invent something that is novel, but which is not capable of use, and he will not be entitled to protection; he may invent or make something which is useful, and he will not be entitled to protection, because of the lack of novelty.

I have been particular in laying out the premises and stating the principles upon which alone patents can be legally granted or refused, because I expect to show by the testimony that some things may have been *invented*, but they are not patentable because they lack utility. There are other things that have been drawn into this controversy that are useful to a certain extent, but they possess no novelty, because they go no further than the devices that had before existed. There are other things that have been drawn in which are not inventions; they began as experiments and went no farther; they were not prosecuted at all, and in other cases there was no diligence in their prosecution, and they never went so far as to be capable of actual use, hence were not useful devices in the eye of the law, and were not patentable or entitled to protection.

At this point I desire to suggest that the term experiment is used in ordinary conversation with two very different meanings. A lecturer is often spoken of as performing an experiment before an audience; he might take a well-known electric machine that had been sold in the markets by hundreds, and a well-known electric light, and in common parlance it would be said that he performed a very successful experiment. So, also, as an illustration, music may be played at a distance and reproduced so that the audience can hear every note. This is commonly spoken of as an experiment; the apparatus, however, might be old and for sale on the market. In this interference there are several places where the word is used in this same sense, viz.: to distinguish the laboratory or lecture-room

use from a commercial use; this, however, is not the legal meaning, so far as patents are concerned.

An experiment in patent practice is something that falls short of an actual or successful demonstration of something useful; hence, where the term experiment is used in the evidence, and it is also said that the device worked well, accomplished what was desired, or nearly so, could have been commercially used, or any expression of this character, we are to understand that the use was not for the purposes of profit or commerce, but was a full demonstration and a success, such as might have been performed in a lecture-room experimental demonstration. When a man has gone as far as this he has made an invention that is entitled to protection according to law, but any man who comes short of this has not made an invention.

One of the duties of your Honor, therefore, will be to disregard the words employed and ascertain what each man had, and whether or not it was a new and useful device or art, and in so doing apply the terms of the statute, exclude the spurious, new, useful and patentable, and give protection only to such.

This brings me to another stage of the principles involved in the questions under discussion. The law defines patentability to exist in any new and useful art, machine, or manufacture. Now, some of the questions involved relate to the art, others to the device.

So far as the art is concerned, it may be stated broadly to relate to the art of speaking electrically; the issues do not relate to the art of transmitting music—that was old, but music is not speech.

It is believed that your Honor will agree with me that the broad question at issue is—who uses the first to conceive and to reduce to practical efficiency the art of speaking electrically? and second, who first made and used certain devices and certain methods?

In regard to the first inquiry, it is useless to in-

roduce any evidence in regard to the transmission of music, because music is not speech; and in regard to the second enquiry, concerning devices, it is immaterial whether they were used in the transmission of speech or music, so long as the devices were adapted to the transmission or reception of sound electrically and were novel.

The importance of considering this branch of the inquiry at this time will be apparent. Prof. Morton makes a very clear statement on this point, and as this part of his evidence corresponds with the expert evidence of other parties, and as he has been introduced in behalf of Messrs. Voelkers & Irwin, they will not question his evidence, and it is to be taken as an established fact that different principles are involved in the transmission of music from those involved in the transmission of speech. Common sense enforces this statement. Many an orator cannot sing a note, many a musician cannot talk intelligently. There are two arts—one of speech, the other of music; but to quote from Prof. Morton, pages 253, 254, Vol. 3.

X-Int. 110. When using instruments, such as the Reis transmitter, for the transmission of musical tones, did you ever observe whether or not any condition or adjustment of the contact points was necessary or important in obtaining the best results?

A. I found the adjustment of the greatest importance, since slight changes of adjustment would make all the difference between success and failure.

111 X-Int. Did you discover any particular adjustment that was necessary to insure success?

A. Only in this general way: the adjustable electrode was first brought in firm contact with the other electrode attached to the membranous diaphragm, and was then drawn back while a loud note was sung into the transmitter, until the operator was aware of a humming or vibration, which indicated a constant rupture of contact with each vibration. This gave us the best results in transmitting musical

notes, so that they could be heard loudly throughout the large building.

112 x-Int. Did you ever ascertain whether or not in instruments such as the Reis transmitter, you could adjust the movable contact point so that this humming sound would be produced under all circumstances, when an attempt was made to transmit articulate speech?

A. I never attempted any such adjustment as that, because I found that any such humming sound rendered the transmission of articulate speech impossible, by causing a noise in the receiver which was almost unendurable to the person listening.

113 x-Int. Did you ever ascertain whether or not articulate speech could be transmitted by an instrument in which the adjustment of the points was such that an electric spark would be visible when talking to the instrument?

A. I never saw such a spark with a speaking instrument, but it was the regular thing with the apparatus used for singing, when, as a matter of course, it demonstrated that the circuit was broken at each vibration.

114 x-Int. If a transmitting instrument was adjusted so that a spark was visible between the electrodes, when talking to the instrument, could such an instrument be used practically for transmitting articulate speech?

A. I think not.

Prof. Morton no doubt told the truth in this evidence, which is amply supported by other evidence, such as that of Mr. Johnson, Prof. Cross and others, and it is not anywhere denied by any one that has any actual knowledge on the subject.

Veckers, p. 145, tells about the snapping sounds; these arose from the breaking of the circuit; this destroyed articulation, but he did not know it.

It is, therefore, to be laid down as established beyond a peradventure:

1st. That for musical transmission the elec-

trodes must separate and produce a humming noise.

2d. That the electrodes produce an actual make and break in transmitting music successfully.

3d. That there will be a spark between metallic points when transmitting music.

4th. That the humming of the electrodes is absolutely destructive of articulate speech.

5th. THAT IS ARTICULATE SPEECH THE ELECTRODES MUST NOT SEPARATE.

6th. That the art or mode of operation involved in the transmission of articulate speech is a different art from that involved in the transmission of music; hence, as a corollary:

(a) Any person that sought to use for speech a telephone that was only adapted to music was utterly ignorant of the first principles involved, and never could and never did succeed.

(b) Such person never started on the art involved, and is not entitled to any protection, and any desire to transmit speech through electrodes could never be realized until there was an apprehension of the principles involved in the art as distinguished from the art of transmitting music.

It is probably true that persons in these interferences, who succeeded in transmitting some musical sounds, thought that it would be desirable to transmit speech, but their efforts failed, because they were not aware of the principles involved.

The first clear understanding of the art of transmitting articulate speech through electrodes was arrived at by Mr. Edison before he gave the order for Case 130, March 23, 1877. This order will be found on page 508, Vol. II., of Edison's Record, and the specification of this case is believed to be the first recorded instance where the art is set forth so that the principles involved are brought to light.

At this point I introduce for convenience of reference tabulated statements showing the official counts in the interferences, the parties to those counts and the *dates alleged* by each party in the preliminary statements of conception and reduction to practice.

Your Honor will bear in mind that these various *dates are not admitted to be correct*; on the contrary, I expect to prove the inaccuracy of some and also to point out erroneous statements concerning the devices referred to.

Interference A.

"The hereinbefore described art of transmitting and reproducing at a distance sonorous waves or vibrations of *any description*, which consists in increasing and decreasing the strength of an electric current traversing a circuit in such a manner as to produce in said circuit a series of electrical waves or vibrations, *precisely corresponding in their intervals of succession and relative amplitudes to the sonorous waves which are to be reproduced at the receiving station or stations*, so that oral conversations or sounds of any description may be telegraphically transmitted" (Gray's 1st claim).

This is substantially the method specified in Bell's fifth claim, and is described in the applications of Edison, Dolbear and Voelker.

Name.	Alleged date of Conception.	Alleged date of Reduction to Practice.
Gray (1).....	About Jan. 1, 1875	June, 1876.
Bell (174,465).....	July and August, 1875.	May and June, 1876.
Edison (130).....	Feb'y, 1873.....	Between Aug. and Dec., 1875.
Dolbear.....	Aug., 1873.....	Between Dec. 1874 and Feb'y, 1877.
Voelker.....	Christmas, 1875.	March, 1876.

Interference B.

"The hereinbefore described improvement in the art of *transmitting vocal sounds* or spoken words telegraphically, which consists in throwing upon the line, through the medium of a *varying resistance*, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air produced by a *spoken word*" (Gray's 2d claim).

This is substantially described in the application of Bell and Edison. Voelker's 1st claim.

Name.	Alleged Date of Conception.	Alleged Date of Reduction to Practice.
Gray (1).....	About Jan. 1, 1875.	June, 1876.
Bell (174,465).....	April or May, 1875.	May, 1875, Method 1, Varying tension of wire, March, 1876, Method 2, Liquid.
Edison (130).....	Feb'y., 1873.....	Between Aug. and Dec., 1875.
Voelker.....	Christmas, 1875.	March, 1876.

Interference C.

"1st. The transmitter, consisting of the combination in an electric circuit of a *diaphragm*, and a *liquid* or equivalent substance of *high resistance*, whereby the vibrations of the diaphragm cause variations in the resistance of the electric circuit, and consequently in the strength of current traversing said circuit" (Gray's 1st claim).

This is described in the applications of Edison and Richmond and patent of Bell.

"2d. In a telegraph instrument operated by sound, the combination with the diaphragm of two or more electrodes placed in electrolytic liquid and operating to increase and decrease the resistance of the electric

circuit by the movement derived from the diaphragm." Edison's 1st claim.

This is described in the applications of Richmond and Gray, and is substantially suggested in Bell's patent.

Name.	Alleged Date of Conception.	Alleged Date of Introduction to Practice.
Gray (2)	Dec. 15, 1875.	June, 1876.
Edison (144)		Two pairs of electrodes used in Aug. 1876.
Richmond	March 1st, 1877.	July 20, 1877.
Bell (174, 463)	Apr'l or May, 1875	May, 1875. Method 1. Varying tension of wire. March, 1876. Method 2. Liquid

Interference D.

"In an electro-hydro telephone, the fluid holding vertically adjustable tubes, within which the ends of the platinum points are immersed as set forth." Substantially described and shown in Edison's application (No. 144) and described in Gray (2).

Name.	Alleged Date of Conception.	Alleged Date of Introduction to Practice.
Edison (144)	July, 1875	May, 1876.
Gray (2)	Dec. 15, 1875	June, 1876.

Interference E.

"In an acoustic telegraph, an armature plate, the electro-magnet for the same, and a closed cir-

cuit passing from the holly of such electro-magnet to the source of undulatory electric energy."

This is the subject matter of Edison's third claim, and is substantially described in the other applications and the patent involved.

Name.	Alleged date of Conception.	Alleged date of Introduction to Practice.
Edison (145)	Sept., 1875	Since Jan. 1, '76.
Bell (174, 465)	July and Aug. June 2, 1876.	
Dolbear	Sept. 20, 1876	Between Dec. 776 and Feb., 1877.
Gray (3)	March, April, May and June, 1874	1874.

Interference F.

1st. A telephone transmitter consisting of a coil of wire, one or more magnets and a disk or diaphragm so arranged relative to each other that a motion of the diaphragm shall induce in a coil of wire an electric motive force, in virtue of the presence of the magnet or magnets."

This is substantially described and shown in the application of Dolbear and Gray, and patent of Bell.

2d. (Formerly H.) "The combination in one circuit of two or more coils of wire, two or more magnets, and two or more disks or diaphragms, so arranged relatively to each other that if one of the disks or diaphragms be put in motion by the voice, by a current of air, or otherwise, it shall induce a transient current of electricity in its associated coil, which current shall actuate the other disks or diaphragms in virtue of the coil and magnets associated with them."

This is described and shown in application of Dolbear and Gray, and patent of Bell.

Name.	Alleged date of conception.	Alleged date of induction to practice.
Dolbear.....	Sept. 20, 1877...	Between Dec. 1876 & Feb. 1877.
Gray (1).....	March & Apl. 1874	May & June, 1874
Bell (174,465).....	July & Aug., 1874	June 2, 1875, & July, 1875.

Interference G.

"A telephonic receiver consisting of the combination in an electric circuit of a magnet, and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality." (Substantially Gray's claim.)

This is substantially described or shown in the applications of Dolbear, Edison, and McDanough, and in patent of Bell.

Name.	Alleged date of conception.	Alleged date of induction to practice.
Edison (148).....	Nov. 1st, 1875.	Dec. 20, 1875 & Public Ex. since
Gray (3).....	Mar. & Apl. 1874	May & June 1874
Dolbear.....	Sept. 20, 1876...	Between Dec. 1876 & Feb. 1877
McDanough.....	Dec. 31, 1867.	June 30, 1875.
Bell (174,464).....	July & Aug. 1874	July, 1875.

Interference I.

1st. A telephonic transmitter, consisting of one or more helices, forming a portion of the main circuit, and surrounding a core or cores maintained in a

magnetic state by the inductive influence either of an electric current or of a permanent magnet in combination with an elastic inductive plate or armature, which is rigidly supported at one or more of its edges, while the portion facing the poles of the magnetic core or cores is left free, so as to be capable of responding to sonorous vibrations traversing the atmosphere or other bodies."

This is substantially Dolbear's 1st claim, and is substantially embraced in Bell's 2d and 8th claims. It is described in application of Gray.

2d. Formerly K.:

"Two iron or steel cores respectively mounted upon the opposite poles of a permanent magnet, receiving magnetism therefrom by induction, and provided with enveloping helices of insulated wire, which form a portion of the main circuit in combination with an elastic inductive plate or armature rigidly supported at one or more of its edges, while the portion thereof facing the poles of the magnetic core is free, so as to be capable of responding either to sonorous vibrations traversing the atmosphere or other bodies, or to magneto-electric pulsations or undulations traversing the helices surrounding the magnetic cores." (Dolbear's 2d claim.)

This is described and shown in Bell's patent.

Name.	Alleged date of Conception.	Alleged date of Induction to Practice.
Gray (1).....	March & Apl. 1874	May & June, 1874
Dolbear.....	About Oct., 1876.	Dec. 1876, & Feb., 1878.
Bell (186,787).....	July & Aug., 1874	June 2, 1875, and July, 1876.

Interference J.

"The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case

for "rendering audible vibration." (Edison's 1st claim.)

This is substantially embraced in Bell's 3d claim and Dolbear's 3d claim, and described in application of Gray.

Name.	Alleged date of conception.	Alleged date of Reduction to Practice.
Edison (141).....	Nov. 1st, 1876.	Dec. 20, 1878, & Public use since.
Gray (3).....	March & April, 1874.....	May & June, 1874
Dolbear.....	Albion Oct. 25, 1876.....	Bel. Dec. 1876, & Feb., 1877.
Bell (186, 787).....	Cannot tell.....	April, 1876.

Interference L.

"1st. The combination in an acoustic telegraph of an electro-magnet, and a polarized armature formed of a plate of iron, steel or other material capable of inductive action and a resonant tube or case." (Edison's 1st Claim.)

"2d. The combination in an acoustic telegraph of an armature plate polarized by induction, a resonant case or tube and an electro-magnet and circuit connections whereby currents are caused to act in the electro-magnet with varying intensity proportionate to the electric waves sent from the transmitting station." (Edison's 2d Claim.)

This subject matter is described in the applications of Bell and Gray.

Name.	Alleged Date of Conception.	Alleged Date of Reduction to Practice.
Edison (143).....	Sept., 1875.....	Since Jan. 1st, '76
	1st claim, Nov. 1875.....	November, 1873.
Bell (174, 465).....	2d Claim, Dec., 1873.....	December, 1873.
Gray (4).....	March or April, 1874.....	November, 1877.

Interference No. 1.

"A spring, forming or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes, and yield to the movement of the diaphragm." (Blake's claim.)

This is substantially claimed by Irwin (claim 3), and is described or shown in the applications of the other parties.

Name.	Alleged Date of Conception.	Alleged Date of Reduction to Practice.
Edison (141).....	Before Mar., 1877.	March 5, 1877.....
Blake.....	June, 1878.....	July 27, 1878.....
Irwin.....	October, 1877.....	Nov., 1877.....
Voeckers.....	May, 1876.....	May, 1876.....

Interference M.

In a telegraphic apparatus operated by sound the combination with the diaphragm of one or more contact points of phosphor, or similar inferior conductor, in the electric circuit, whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm (Edison's 3d claim.)

This is described and shown in Berliner's application.

Name.	Alleged Date of Conception.	Alleged Date of Reduction to Practice.
Edison (141).....	April, 1878.	April, 1876.
Berliner.....	Jan'y, 1877.	April 12, 1877.

It appears to be proper at this point to briefly review the decision of the Examiner of Interferences.

The manner in which he treats the subject under consideration is peculiar. His duty was to consider solely the question of priority of invention upon the various counts presented to him, and to call attention to any inaccuracies in the proceedings; he does no such thing. He reminds me of the Irishman who stumbled against the guide-post on his way home one dark night and broke it down; he stops and sets it up, true to his nationality, pointing in the wrong direction; he then lights a match to find which way it points for his home, and following its wrong indication never reaches his destination. So in like manner the Examiner of Interferences stumbles against the various counts of the interferences that are set up to guide him in his decision, breaks most of them down, sets them up the wrong way and lights the match of testimony to examine the subject, and follows his own sweet will until he lands without a chart or compass in a mass of absurdities, and exhausted by the effort, resigns and becomes the counsel for one of the contestants in another branch of the telephone litigation.

These results are not to be wondered at as it will be remembered that the present interferences were argued in November, 1881, and the decision was not rendered until July, 1883. A year and a half in deciding an interference is long enough to muddle any man.

The Examiner says (p. 3) he cannot amend or modify the issue, but must decide the point submitted, and yet in deciding interference E, he frames his own issue (p. 328) regardless of the actual issue, and makes a decision based on his construction, and he also leaves out the second count in this interference I, and makes no decision on it.

INTERFERENCE B is expressly limited to a "*medium of varying resistance*." The Examiner construes Bell's patent as possibly containing the varying resistance, but Examiner of Interferences says (p. 381) that the Bell patent does not contain the slight-

est reference to a variable resistance transmitter, and yet he decides (p. 337) in favor of Bell, after admitting that he did not have the essential feature of the count in this case I.

INTERFERENCE C. The interference is based mainly on a *liquid resistance* in both counts, and it is admitted (p. 41) that this feature is not in the Bell patents, and that none but Edison shows or claims count 2, and yet on page 338 a decision is given for Bell.

INTERFERENCE E is based on Edison's third claim in application 145. It is not limited to a speaking telephone, and yet the Examiner of Interferences tortures the issue (p. 42) so as to make it apply only to the art of transmitting speech (Inter. A) and on that basis decides in favor of Bell. Edison knew what he had, what he described and what he wanted to secure. The other parties never made the claim in this issue. Edison had the device covered by this claim long before any of the other parties, and to very the issue and construe it such a way as to make the issue something else than Edison made it, and to which his application, claim and proof related, is a high handed proceeding that cannot be tolerated by your Honors.

In order to have even a pretext for his action, he strips the issue of its limitations (see p. 43, line 6-8), which he has no authority for, and then at end of page 46, admits that the claim is not limited to an articulating transmitter, and finally, when the decision comes to be announced, it is based on an articulating transmitter (p. 341).

INTERFERENCE G is decided in favor of McDonough on the ground that the issue relates to the devices irrespective of use for an articulating transmitter. No decision could have been rendered in his favor if the count had been adhered to, because McDonough did not have the devices of the counts, he did not have a "telephonic receiver," in which "*sonnds*

thrown upon the line may be reproduced accurately as to PITCH AND QUALITY." The Examiner of Interferences tells on page 52 how McDonough sought to introduce new matter into his application so as to make it apply to the speaking telephone, and notwithstanding the fact that his device never was a speaking telephone capable of reproducing sounds accurately as to pitch and quality, still he decides in McDonough's favor upon an apparatus that according to his own admissions never could fill the requirements of the count, for nothing but a *speaking telephone can or ever did reproduce accurately all the sounds as to pitch and quality.*

INTERFERENCE J is decided in favor of Bell; Edison makes the claim of this count in his application 118, he shows a resonant case; the *case is made an element of the claim.* The Examiner of Interferences ignores this element because the other parties do not show resonant case. That they do show a case and that every case has more or less resonance, must be admitted, and yet this lucid Examiner of Interferences (after knocking over the sign post, sets it up again the wrong way) leaves out the element referred to and decides in favor of Bell, because he had an iron armature, not an iron diaphragm as the Examiner of Interferences calls it.

The same reasoning is pursued in *Interference L*, and the additional falsity brought forward that Edison abandoned his devices, when the whole evidence shows diligence and persistence on his part, and constant use of the features in question.

I think I have shown enough to convince your Honors that the whole decision of the Examiner of Interferences, in the matters decided against Mr. Edison, is utterly unworthy of any credence, as it started from false premises and ended in a muddle.

Brief of Argument in Behalf of Edison in each Division of the Interferences.

INTERFERENCE, A.

Mr. Gray is responsible for the wording of interference A. It is particularly objectionable and unhappy; it mixes up the transmission of articulate sounds with music and every other sound, and it applies to the *art* and not to the devices.

The issue should be divided into two parts:

1st. The art of transmitting sounds electrically in a circuit containing telephonic receiving and transmitting instruments, consisting in communicating to an electric current upon a line undulations corresponding to the sound waves in the atmosphere, without interrupting the current.

2d. The method of transmitting sounds electrically in a circuit containing transmitting and receiving instruments, consisting in varying the electric condition of the line by induced currents set up by the movement of an armature adjacent to a magnet and helix connected with the line.

If this had been done Mr. Edison would have said let Mr. Bell have these claims, so far as he, Edison, was concerned, and let Mr. Gray contest the question with Mr. Bell, if he desires to do so.

Mr. Voelckers never had any device to which either of the foregoing counts could apply. The lack of consciousness in the declaration of interference has opened the door for Mr. Voelckers to come in, and this rendered the questions between Bell, Gray & Dubucq unnecessary confused.

So far as the wording of the *interference A*, as it is OFFICIALLY STATED, is concerned, your Honor's attention is directed to the next point.

Probably there is not one of the present contestants that understands the use of language better than Professor Bell, yet in his application filed February 14, 1876 (patent No. 174,465), he does not say

one word about articulate speech; the patent is for a telegraph.

It is all wrong to suppose the telephone system is based on this patent: the undulatory current in Edison's patent, 111,777, granted in 1873, is a bar to the validity of all the claims in this Bell patent but the last, and I ask your Honor here to compare them.

There is nothing in the Bell patent, 174,025, that would give any information as to the art of transmitting articulate speech, and it ought to be excluded from the present interferences. (See Johnson, page 387, Q. 18, and other testimony on the same point, such as Watson, Bell's own witness, p. 726.)

So far as Bell's second patent, No. 186,787, is concerned, the evidence clearly proves that the devices shown in Figs. 1, 2 and 3, are the same as those in Edison's application, No. 118, Fig. 2. These devices were made by Edison and used in November, 1875. They are Exhibits A, A', shown on pages 515, 514, Vol. 2.

They are operative instruments, and were put into use in their dirty and partially broken condition during the examination.

The devices of Bell shown in these figures were not made until October or November of 1876. I therefore claim priority of invention for Edison over all parties to Inter. A, and also in all the counts in which these matters are contained. These are farther referred to in connection with Interferences G and I.

Gray did not attempt to transmit articulate speech until February, 1876, and Edison had preceded him six months in his efforts, and Dolbear did nothing before August, 1876; therefore he may as well be regarded as laid on the shelf.

INTERFERENCES B AND C.

So far as the count in Interference B is concerned, it is to be understood as broadly covering the trans-

mission of sounds telephonically, where there is a *varying resistance* to the electric currents, corresponding to and resulting from the movement of the air in spoken words.

This varying resistance must be distinguished from a neutralizing electric force. In case A it is to be understood that the induced current opposes and neutralizes or partially so the current on the line, or on the other hand augments said current. A *resistance* to an electric current can never be so applied as to augment the current, hence we are to understand this Interference B as distinguished from A, to the extent that a continual flow of the electric current is resisted more or less, and so made to pulsate.

Interference C, count 1, brings into combination with the diaphragm a liquid or substance of high resistance; and

Interference C, count 2, defines the two or more electrodes as placed in the electrolytic liquid—and receiving motion.

These three counts are only slightly varying phases of the same subject matter, and I propose to treat them together so far as all the parties are concerned except Voelkers.

In the Edison Patent, No. 111,777, of 1873, the resistance is brought into the electric circuit and the resistance is varied by a movement and the current made to pulsate.

In June, 1875, Edison conceived the invention of combining this device with the Reis Telephone; that is the date of conception. This evidence is found on page 6 of Edison's record. In November or December, 1875, he made the water telephone and demonstrated that the devices could be operated; many more were made in 1875-6. Exhibit Water Telephone Instrument is one of them, page 518, vol. 2. Exhibit 6-4, November 16, '75, shows the points at issue, the resonant device being a bar.

Variable resistance is shown in same combination

in Exhibit 9-9, November 16, 1875, in the form of a German silver helix.

Exhibit 10-9, November 18, 1875, shows mercury, and also numerous light contacts to form the varying resistance to pulsate an unbroken current.

See Edison, pp. 12 to 15, Vol. 1.

Also Repolarization of Battery, November 17, 1875, Exhibits 2, 10, &c.

Gray did not attempt to transmit articulate speech until February 11, 1876, and I fail to find any device corresponding to the issues in these cases prior to his caveat and sketches, February 11, 1876. Clearly, therefore, Edison antedates Gray on the counts of cases B and C.

Mr. Bell never had any varying resistance in his circuit, except the piano string resistance, which was not proposed for use in the combination called for in these cases, and was a simple experiment that was never repeated. Bell claims to have used the water resistance in March, 1876, and never prosecuted it. This was four months after Edison used the water, and three years after his water resistance patent of 1873.

Hickman has taken no evidence, and by his preliminary statement he did nothing until 1877.

English patent No. 24 of 1858, referred to by Voelker is simply a water rheostat, and Reiss device has no variable resistance; neither applies to this count.

Voelker's never had any variable resistance of any kind, and furthermore, his devices were not made until 1876, and were undeveloped experiments; and there was no diligence in adapting or perfecting; hence he has no standing in these cases.

Edison, alone, is the first inventor, and entitled to protection in cases B and C.

I now propose, more fully, to consider the position of VOELKERS IN INTERFERENCES No. 1, AND A AND B.

INTERFERENCE No. 1.

In regard to interference No. 1, it is to be remarked that the claim has been made by Mr. Blake, it has

not been made by Mr. Edison, and it is competent to call attention to the impropriety of raising such an issue.

A spring forming or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and a diaphragm, and an initial pressure are old devices.

On page 245 of evidence for Voelker & Irwin, there is a picture of the Reiss transmitter, copied from the Report of the Physical Society at Frankfurt, 1860-1. The description is as follows:

"In the cubical block of wood, *r, s, l, u, v, w, x,*
"there is a conical perforation *a*, closed at one end
"by a membrane *b* (pig's intestine), upon the mid-
"dle of which there is cemented a conducting strip
"of platinum; this is connected with the binding
"screw *p*. From the binding screw *u* another *thin*
"strip of metal extends *until over the middle of the*
"membrane, and ends here in a platinum wire
"placed at right angles to its length and surface."

There is a model of this instrument in this case, produced in behalf of Voelkers & Irwin, which shows this Reiss instrument, and your Honor will see that it contains this count of the interference.

It will be found that this evidence was introduced on the rebuttal, and was the very last testimony taken, viz.: on May 11, 1881, and there was no opportunity to make any motion to dissolve this branch of the interference before that time, and it appeared preferable to await the hearing of the case, and not complicate or delay matters by interlocutory motions, and to depend on your Honor under Rule 120, calling the attention of the Commissioners to this statutory bar to this particular point of interference.

In this Reiss instrument there is a "*thin piece of metal*," which cannot help being a spring to the extent of yielding with the movements of the diaphragm, or else, if it bent, and staid bent, the very first movement would so separate the electrodes that they would not touch again; there is an electric

circuit, the platinum point forms one electrode, the platinum strip on the diaphragm forms the other, and there must have been contact, and hence initial pressure.

In the "Builder, May, 1869," see pages 771-2-3, vol. 3 of record, the Van Der Weyde apparatus, made according to his understanding of the Reis telephone, contains a similar device, with the exception that no mention is made of the "thin strip of metal," but the description speaks of "the point coming in contact with the small vibrating disk," &c. It may be inferred that in the Reis instrument the circuit was intended to be made and broken; admitted, but such also was the case in the Voelkers instruments.

On page 56, vol. 3, Voelkers, in describing the operations of his instruments that he had made before fall of 1877, and which he took out to Irwin's place, says that Irwin spoke of his TALKING TO AN ELECTRIC LAMP; then on page 71 he says, in answer to x-Q, 142:

"I understood by that that the current going through the point of contact of the diaphragm, which, when he carefully adjusted it, showed a very bright spark which it maintained for quite a while; what he meant by that was, by talking against the arc of an electric lamp in circuit with a telephonic receiver and battery, if the electric lamp, might be utilized as a telephonic transmitter."

Language cannot be plainer than this, to show that there was a rupture of circuit, and consequently a spark. Prof. Morton, pages 283-4, as before quoted, expressly says that the humming sound indicates rupture of contact, and (in answer to x-Q, 113) says: "I never saw such a spark in a speaking instrument, but it was the regular thing with the apparatus used for singing, when as a matter of course it demonstrated that the circuit was broken at each vibration," and in x-Q, 114 says such an instrument could not be used for articulate speech.

Voelkers has not shown that there is any difference between any one of his devices and the Reis telephone.

I ask counsel for Voelkers to point out one feature of difference in the mode of operation, and if he does not do so your Honors will be justified in assuming that the devices are substantially alike.

Voelkers (pages 88, 89, vol. 3), admits that the devices are old.

I am only using the evidence of Voelkers to show that up to the fall of 1877, when this proceeding took place at Irwin's own place, and with the full knowledge of both the contestants, Voelkers & Irwin, neither party had the most remote idea of the true principles involved in the transmission of articulate speech. These experiments were made by them and were utterly unimportant; singing was heard, and a word occasionally.

This was four or five months after Case 141 of Edison, now in interference, was filed, and six or eight months after Edison's Case 130 had been filed, in which the principles of the articulating telephone are clearly brought out.

It is not my purpose to extend this argument concerning the claims of Voelkers and Irwin under the count, in *interference No. 1*, other than to say:

1st. That Irwin did nothing until October, 1877, which was four months after the case of Edison No. 141 was filed, July 20, 1877, hence Irwin is entirely out of this count.

2d. That what Voelkers did was an experiment; it was valueless. His apparatus never transmitted speech; it was incapable of being used, and his own witnesses show that to be the case.

3d. That what Voelkers had was the same in substance as what Reis had made fifteen years before.

So far as VOELKERS BEING A PARTY IN INTERFERENCES A AND B, all the remarks before made are applicable; and your Honor will, in addition, bear in mind that there is one clause in the law which

tells fatally upon him, that is, "using reasonable diligence in adapting and perfecting the same."

"Now, Mr. Voelkers has not produced any instrument capable of use; he has never perfected his crude ideas; he has never given the world anything that will benefit it in the least, and he admits that he knew about it in the least, and he admits that use of it before he communicated with Mr. Irwin (see Voelkers, pages 73-74). The world had been informed in July of 1877, of Edison's carbon and other telephones. Voelkers heard of it, and he supposed justly that what he had done was not patentable (see pages 172, 173, 174). He knew that he had not made an invention; he knew he had never made a successful device; he knew he was not entitled to protection, and he only entered the field at the request of interested parties to try and block the settlement of those interferences (see Voelkers, page 30, Vol. 3).

The count in Interference 1, is not any particular apparatus, but it is the art of transmitting speech.

Now, it is apparent that Voelkers was endeavoring to transmit speech by adjusting the parts to give a spark, and breaking the circuit. I have shown, by his own witness, that speech can never be transmitted in that manner. There is no provision in any one of the Voelkers devices for "increasing and decreasing the strength of an electric current," to correspond to the sonorous waves, "so that oral conversation can be transmitted."

In Voelkers' exhibits the currents will be either made or interrupted; there is not one of them that is adapted to continuing a current and pulsating it so as to correspond to articulate sounds.

It is admitted substantially by Voelkers' counsel that the transmitters were good enough, and that the trouble was with the receivers. Here the interference is recognized. It was the transmitters that would not work.

Voelkers could have taken a Reis receiver or a Bell receiver in 1876; these would have proved whether or not the fault was in the transmitters.

Voelkers experimented to March, 1878, which was nearly a year after Edison's application No. 130 was filed, April 27, 1877, nine months after No. 141 was filed, July 30, 1877, and six months after No. 144 was filed, September, 1877.

Edison was the originator of the devices that correspond to the count in Interference No. 1 before either of the contestants. He had several springs, one bearing against another, and a circuit passing through the electrodes on the springs (see Caveat 71, filed December 2, 1875), which was before Voelkers did anything. Whether the springs are acted on by a reed or other vibrating body, the action on the circuit is the same (see Edison's evidence, pages 38, 39). The exhibit 162-15, shows the diaphragm and spring. This was made in November, 1875.

The devices in English patent No. 2900, granted to Edison, July 30, 1877, show the subject of Interference 1, two years before Voelkers' application (see Figs. 9, 10, 11, 16, 19 and 20).

The patent No. 295,013 of Edison shows a spring. Ex. 10-11 has a spring to vary resistance. The device in Fig. 12 of his caveat No. 74 also shows this count. See also patent 203,014, exhibits 42-11, 106-11, 112-11, 2-12, 6-12, 163-12, 188-12, 7-13, 42-13, 112-13.

Voelkers claims that he was the first to use a metal diaphragm and adjustments for electrodes; this is absolutely incorrect. Edison had adjustment for vibrating armature in 1873. (See patent No. 141, 777, also metal diaphragm in November and December, 1875, Ex. A. A1).

Voelkers' first metal diaphragm was in May, 1876.

See also Edison's patents 195,050, 186,330, 198, 057, and 182,906, all filed in April and May, 1876, and showing devices similar to the metal diaphragm.

Caveat 74, filed Jan. 14, 1876, describes diaphragm of metal to resonant case, and devices for adjusting some of them.

Exhibit 75, Fig. 14, shows also case diaphragm of metal (see Figs. 1 and 2, and page 577, vol. 2).

From Dec., 1875, to fall of 1877 and onward, Edison was unremitting in his efforts to produce a speaking telephone, and the result was the best telephone yet produced.

The particular line of Edison's efforts has been unvaried; it remains unvaried to-day. His own language expresses it on pages 41 of his evidence. He sought, from first to last, to maintain on the line an unbroken circuit, and a rise and fall of electric condition corresponding exactly to the atmospheric disturbance by the voice in articulation. He was very well acquainted with the musical telephones and telegraphs that had preceded him, and he had also been engaged in constructing and using outside telegraphs wherein the circuit was maintained, so that the interruption of the transmission of one tone over the line would not interfere with the transmission of other tones; his Patent No. 198,098, introduced in evidence in this case, clearly shows these facts. This was applied for April 6, 1876, and shows a complete system. This was about the time Voelkers commenced his efforts.

It appears that Mr. Irwin, the financial backer of Mr. Voelkers, knew what Voelkers was trying to do. He took him into his employ in January of 1878, and tried Voelkers' various electrical traps to see what there were of them. Irwin was amply able to bear the expense of applying for patents on all Voelkers' contrivances; Voelkers cannot plead poverty with Irwin as his financial backer. He, Irwin, put in his application now in interference, May 21, 1879, and it is not until 1879 that the first application is entered for Voelkers.

Meanwhile, Edison had filed in 1876 and 1877 thirty-four applications, twenty-six of which related to acoustic and speaking telegraphs and telephones, thirteen or fourteen of these had been patented, the present interferences had been declared March 26, 1878, a year and a half before Voelkers filed one of

his applications, the preliminary statements of every person but Voelkers and Irwin had been filed and had been open to the public for four months before the date of Voelkers' application of September 26th, 1879, and having access to the files of all the pending interferences his counsel having been the counsel for Richmond, who was first included in these interferences, does it appear strange that he could get these old exhibits just far enough back to entail great trouble on the other parties in the contest? But in his efforts he has failed to establish that he ever made an invention in the eye of the law as explained in the early part of this argument. He never made a discovery because all that he did had been done by Reis fifteen years before him. He did not know in 1876, nor even in 1889, when his evidence was taken, what were the necessary principles involved in the art of transmitting and receiving speech electrically, and, singularly, with all the herculean efforts that have been put forth to establish his position, he is antedated clearly by Edison in every particular.

In the matter of public knowledge and use of the devices in controversy, Voelkers should be excluded from prosecuting his application of September 26, 1879. In June, 1877, the "Journal of the Telegraph" published a drawing of Edison's pressure relay, and spoke of his speaking telephone (see page 629 of vol. 2). In July, 1877, the researches of Bell, Gray and Edison are spoken of in numerous publications, and the "Journal of the Telegraph" (page 629) sets forth the features of Interferences 1, and A and B. The Edison telephone was put into public use September 2, 1877, as shown by the Sunday "Trojan" of that date (page 633, vol. 2). Besides, all that was done by Bell at the Centennial, and publicly, more than two years before the application of Voelkers. Because Voelkers stood by for more than two years and did not raise any objection or make any application, and his money lender is equally to blame. If for no other reason Voelkers

should be thrown out utterly from the Interference No. 1, and along with him must go Mr. Irwin, because he is antedated by the records of the case.

If this was done the contest would remain between Edison and Blake, and it is utterly useless to consume time in considering him in this interference No. 1, because Edison's application No. 141, containing the subject matter, and much else, was filed July 20, 1877, a year before Blake did anything.

It may be contended on the part of Voelkers that Edison had not showed the public use of the devices represented in his present application No. 141. That is not necessary. When an application for a patent develops the mode of operation of an instrument, describes the same so that others can understand it, it matters not whether the device has ever been tested; and to render questionable the right to priority upon the records of the office, positive evidence would have to be produced to show that the device in the application would be absolutely inoperative.

There is also ample evidence to show that the devices of this application, No. 141, have been successfully used.

The apparatus (Ex. 8—9, Nov. 16, 1875) worked on the same plan as the devices shown in Edison's Application 141, only the diaphragm was displaced by a tuning fork, the known equivalent; the resonant base in Ex. 10—9, Nov. 18, 1875, and the bearing levers and contact points are the equivalents; the reel and springs (Ex. 22, 9) are exactly the same as the devices in the Application 141, so far as opposing springs and the vibrating body between them. The vibrating body moves the springs and causes the variations in the electric currents, and as these were actually operative devices made before Voelkers commenced doing anything, they carry great weight, not only as sustaining the Application No. 141 itself, but also as showing that Edison had gone further before Voel-

kers began than Voelkers ever went in devising the matters in issue.

The various devices made early in 1877, immediately before the application 141, of July 20, 1877, show the use with the diaphragm of the same springs that had been used operative, and there is not one word of evidence to show that the perfect operative character of the devices of this application can be questioned.

I now propose to glance briefly at the other divisions of the interferences.

INTERFERENCE D.

In regard to Interference D, the count is not limited to any combination of devices; it relates to an adjustment of the electrodes in the water.

The device is substantially met by the screw λ , in Edison Patent 141,777, which varies the distance between the electrodes; whether the tube is moved or not makes no difference in the operation.

Edison, however, antedates Gray, because Exhibit Water Telephone, the first of which was made in Nov., 1875, antedates Gray more than two months on the entire device, and I fail to find any evidence of the adjustability of Gray's water-holding tube prior to his application No. 1, Oct. 29, 1879.

INTERFERENCE G.

So far as the count in Interference G is concerned there is no difference between it and the Reis device, except in the use of a diaphragm instead of a plate.

Bell did not have a diaphragm in close proximity to the magnet until latter part of 1876, when the device shown in patent 186,787 were made. In Fig. 7 of patent 174,465 there is separate armature intervening between the diaphragm and the magnet.

hence this cannot be properly included in this division of the interference.

Mr. Gray will probably contend that his wash basin is a diaphragm, and that his blacking box also was a diaphragm. It has evidently been Mr. Gray's purpose in making the claim in question to employ terms that are not correct. If any person wishes to use either of his original devices in a telephone, I presume Mr. Gray will furnish all the wash basins and blacking boxes desired, but it is submitted that ordinary judgment should be applied to this matter, and a diaphragm should be interpreted as meaning that which the word implies, viz., a thin round article and a case that supports it.

Edison is the first to provide this device. It is in Exhibits A, A¹ and was made in November, 1875, and was practical and operative in every respect, and multitudes of others were made after that time.

Edison's Elys. A, A¹ were adapted to and did receive composite tones and speech was heard—see Huff, p. 275, Vol. 2, Ints. 9, 10, 11; Johnson, p. 283, middle p. 281 and bottom p. 283.

These Elys. A and A¹ were connected up during the examination, and one was used as a transmitter and the other as a receiver, and in their damaged duty condition worked well (see pp. 308 and 309, Vol. 2).

Priority, therefore, is claimed for my client on this point.

So far as Mr. McDonough's evidence goes, it may be said that he had a diaphragm and a magnet in close proximity thereto, but his device was only experimental; it never rose to the dignity of an invention, and the magnet did not act on the diaphragm, but upon an intervening piece of iron.

If a man is to be permitted to bring into this controversy a device said to have been commenced in 1867, and laid aside from then to 1871, and then laid aside again till 1875, there will be no protection to patent property. Besides this there is no evidence that McDonough ever did anything that was useful

or operative, his devices were of the crudest kind, and did not accomplish any useful object; they were mere toys; he has divided his application and taken his patent No. 248,002, Oct. 4, 1881, for the only novelty he had, and he is not entitled to any further protection.

McDonough had a circuit breaker and nothing that could be used to transmit or receive speech. Interference G implies a transmitter capable of sending composite and all kinds of tones, otherwise it relates to an inoperative combination.

Edison did have devices that sent all kinds of tones and sounds over a closed circuit by the numerous reeds, and they were heard in Nov. and Dec., 1875. There is no evidence that Gray's device was used for other than musical tones or that it was capable of use.

Edison was the first to have an instrument capable of receiving all kinds of tones and sounds and that was actually used for that purpose.

INTERFERENCE J.

In this INTERFERENCE J the diaphragm is to be secured to a resonant case; it is to be of iron or steel.

Bell did not have any such device until November, 1876.

Dolbear had nothing until October, 1876. Gray had a tin wash basin which does not meet the counts, and his blacking box was not a practical device, was experimental, never presented, never was capable of useful application, and on the principles heretofore laid down never was an invention in the eye of the law and not entitled to protection.

Edison had this iron diaphragm in November, 1875; it is in Exhibit 1 and 2, and its use has been shown practically from that time down to the present; hence I claim a decision for him on this point.

INTERFERENCE I.

This calls for electro-magnet, polarized armature, and a resonant case in combination. Also these in connection with reverse electric currents.

Mr. Bell has shown the magnet and polarized armature, in some instruments, the magnet, an instance, but not the combination of these devices prior to his application of February 14, 1876.

Gray has not shown a practical use of these devices; he experimented with both magnet armature and case; he has not shown that the armature was polarized; neither Gray or Bell has shown that the reverse currents were made use of. Edison has shown the use of these.

It is therefore claimed that, Edison is entitled to both these claims; they are claims that he has asked for; they are shown in his application, No. 115, the apparatus made by him in November, 1875, and which is Exhibit B, page 516, contains all the devices of this issue; he stands really alone in the claims for these features, and he should have them, as neither of the other contestants has given proof of prior use of the subject matters claimed.

INTERFERENCE M.

This case has remained in an indefinite position, it is nominally in the present set of cases. Mr. Berliner has not taken any evidence. Edison has proved the use of plumbago in 1875, and from then along to the present time.

The application No. 130, filed April 27, 1877, sets forth the use of plumbago.

I propose briefly now to review some of the grounds set forth in the printed arguments of the other contestants.

Many of the points presented by counsel for McDonough have been gone into exhaustively by counsel for Bell in the printed arguments, it is therefore unnecessary here to consume time on those points. I simply say that the evidence is clear from McDonough's specification that his transmitter was only a circuit breaker, and never could be used to transmit speech, and never was so used. It might have transmitted music, and the listener supposed he heard the words. McDonough distinctly sets forth that he has a circuit-breaking transmitter; there is nowhere any intimation that he had a device to produce *rise and fall of tension without break of circuit* or interruption of current.

Edison had, in 1873, done more for the successful development of the *principles* of the telephone than McDonough ever did.

Edison had the rise and fall of tension in the circuit in his patent, granted in 1873, long before Bell; he availed of the same thing in the quadruplex of 1873, and in the acoustic telegraphs, the patents for which are in evidence, and were complete useful devices. And now comes the amusing part of the case: after McDonough's counsel had heard the arguments before presented, and saw that a circuit breaker was fatal to his client's claim, he adventurously tries to manufacture an invention for his client by calling your Honor's attention to the wonderful properties of German silver.

I remember well when old Dr. Fyfe's vainglorious created great excitement over his German silver, and people were afraid they might be deceived and take German silver in place of the genuine; it was soon found to *turnish*, and it never had the right *usage*; so the claim of McDonough's counsel that German silver is the important thing, is destined to *turnish* under the light of investigation.

He says that it has greater resistance than platinum. Well, suppose it has, what difference; he does not tell us what *benefit* results from the resistance. Perhaps he did not remember that a coil of

the copper wire in circuit would make a similar resistance. The utmost the German silver will do is to *obstruct* the passage of the electricity and *render it necessary* to increase the battery power.

The German silver becomes like a *resistor* or resistance in a telegraphic circuit, and nothing more.

To illustrate, I have a large pipe through which water is flowing; I cut a section out of that pipe and put in a small pipe; now, one of two things must happen, the flow of water will be lessened to the capacity of the small pipe, or else the power must be increased to drive the water faster through the small pipe to keep up the flow.

There is nothing *curious* in the conductivity of German silver under variations of motion or pressure, and the *only result* is a waste of battery energy *exerted to overcome the resistance*.

McDonough's circuit breaker is illustrated exactly in Edison's evidence, questions 247, 248, 249 and 251.

A drum stick on a drum head will not rest on the membrane when it is vibrated, neither will it follow it; there will be a movement due to the inertia and to the membrane striking the circuit breaker like a bat strikes a ball.

McDonough's circuit breaker works just this way, and his counsel made a very apt illustration when he said it was not necessary that this circuit breaker should be on a drum head or diaphragm; it might be on a board or on a table; he evidently did not know that it would work better on a table than in the way McDonough used it, because it would not be exposed to such a powerful vibration. The very fact of McDonough using this device under the *very worst* circumstances possible shows his ignorance, and develops the fact that he never made an invention in the eye of the law.

There is no reliance to be placed on what McDonough had, as the original devices have been lost, and memory is very treacherous, especially in a man that is constantly sick.

The transmitter of McDonough has a rate of vibration of its own; the tighter the membrane is strained the more rapid the vibration. This will interfere with speech, and the larger the drum the worse it is. Let us well understand this when he made his diaphragm about an inch in diameter. The same thing is to be understood in relation to the receiver; it has its own rate of vibration, and the larger it is, the more difficult for the magnet to manage it and cause it to give out the correct tones.

Counsel would fain make your Honors believe that the ignorance of counsel was the reason of the statements in McDonough's specification. McDonough was not and is not a novice in patent matters.

If his counsel was ignorant that was all the more reason why he was more likely *simply to put down the inventor's ideas*, instead of correcting those ideas and assisting by his own knowledge.

Mr. McDonough must be held by his specification on just the same ground that I contended Mr. Westers must be held to his statements that his device was an electric lamp, a circuit breaker, &c.

Mr. Wilsey, Int. 8, page 5, of McDonough's record, calls McDonough an experimenter, and says he has been *experimenting 16 years*. There is not a word of evidence to show that his telephone was anything more than a useless *experimental toy* thrown away, broken up and abandoned until after Edison had conceived the principles involved in the battery telephones, and had mentally combined the necessary instrumentalities and tested many of them.

We are asked to believe that the important thing in the telephone is the transmitter. McDonough's receiver is good for nothing unless some instrumentality is made that will transmit off tones.

You may be asked to believe from my remarks about music being a different art to speech, to infer that you could not hear music on a telephone. I implied no such thing. When music is reproduced it is wanted to be *loud enough* to be heard by numer-

ous persons. The efforts with musical telephones were with reference to reasonably loud reproduction. *When that is the case speech cannot be transmitted. When both music and articulate speech can be received on the same instrument, it is only on the telephone of to day that has to be listened to, and which works on a closed circuit, instead of the circuit being broken as in all the successful musical transmitters.*

The last clause of the printed argument for McDonough is about as clear as the sunshine at mid night. McDonough's application was filed April 10, 1876. I fail to find that *after* that time Bell adopted a membrane from a diaphragm with metal on it.

Bell adopted Edison's metallic diaphragm *boldly*, not anything that McDonough had.

So far as McDonough and Voelkers are concerned, there is *nothing to show that they had any portion of the telephone of today; their transmitters were circuit breakers that could never be used with articulate speech—they did not produce an instrument any more capable of commercial use than was the first telephone.*

The receivers of Voelkers are all out-dated by Edison's Exhibits A and A' several months; and McDonough's receiver is utterly unreliable and does not contain the devices of the telephone of today—he never made an invention legally.

In April, 1875, when talking to Eastman, McDonough, p. 508, says: "I know that I can make a machine that will send speech over a wire"—he does not say, I HAVE made such a machine. Eastman replies: "If you *know* you *can* do it, why *not* 'er you? Well, McD. has never made an instrument that was put into use even in his own house, or office or factory. It cannot be possible that such a device, if it had been useful, would have remained without being used. The fact of McDonough not using his own device is evidence that it was not adapted to use.

The arguments of counsel for Bell as against Voelkers, Gray and McDonough should carry great weight, because they correspond to the premises that Mr. Edison has always contended for and are in harmony with the principle laid down throughout this argument, and with the conclusions and facts to which your Honor's attention has been called.

If these gentlemen had been as frank and candid as Mr. Edison has been, the labors of your Honors would be reduced to a minimum and there would be nothing to do but to make the following decision:

1st. Mr. Irwin's dates are too late; he is out dated by the record, he must be laid aside. This point I think all the counsel will concede, for no argument has been presented claiming priority for Irwin on any point.

2d. Voelkers experimented only. He pursued a mode of operation that never could succeed; he was following Bell as closely as he could on the transmitter; he is antedated by Edison; he is guilty of negligence; has never shown any diligence, and all concerned with him have acknowledged that he never made an invention, and is therefore not entitled to protection.

3d. That McDonough comes under the same ban as Voelkers; that he never had a useful transmitter—it was a circuit-breaker, pure and simple, and so called and described in terms that render its character unquestionable; that he is guilty of unreasonable delay in prosecuting his experiments; that his proof is not above question, as it depends on memory and not original devices; that his receiver is not useful in the telephone system, and is not entitled to protection.

4th. That Mr. Gray had no closed circuit, and hence, did not have the necessary elements for practical use.

In Edison's Patent No. 186,339, applied for May

16, 1876, long before Voelkers' devices were made, there is a closed circuit, springs that put on and take off part of the force without break of circuit, and there is the vibrating device, whether rod or diaphragm, the operations are the same.

Edison's Case 141 contains the issue of Interference No. 1. It is put into it, and it is for an operative instrument.

The application was filed July 29, 1877. Edison must be allowed to stand on the date of his invention as shown, because he antedates Voelkers, and had a practical apparatus. In fact, he need not show anything prior to the filing of his application, because his apparatus has been demonstrated to be operative and Voelkers' has not.

Prof. Morton (p. 273, ans. 74-80) states that he has made a duplicate of Edison's device in case 141; that it is superior to Voelkers', because it contains carbon in addition to the springs. Morton to-morrow that issue, case 1, is found in the Edison application 141, and hence, Voelkers must not be allowed to object either to the issue or to the Edison case-141, as containing that issue.

Morton admits that Edison's devices, 141, actually did work, and he gives reasons which actually show superiority in Edison's devices, although, at the same time, finding fault with the operation as making too much difference in current. This is a merit, rather than a defect.

Morton's reproduction of Edison's 141 did actually talk well, and this case 141 was filed three months, at least, before Irwin did anything, and, as before mentioned, Irwin must be regarded as entirely laid aside.

The very long brief on the part of Bell, relative to Edison's evidence, rather mixes up statements that are very clear in the evidence itself.

Edison pursued one general plan from first to last, viz: to avoid breaking the circuit, and, at the same time, produce rise and fall of tension.

The devices of Edison that are called circuit

breakers by Bell, did not break the circuit; they operated as shunts only (see case 148 and caveats); they opened or closed a second route; they are like a pipe

with two branches, with a cock in one of them; the current always flows, but the strength will be varied by opening and closing the cock. It is utterly incorrect that Edison used circuit breakers.

You are asked to believe that all Edison's sketches, &c., were prepared for use as evidence. That is not so. They were only prepared as records, because without them dates and facts would be very difficult to define.

You are asked to believe that Edison's devices that had any kind of a tube, were simply resonators that destroyed all tones but the one intended. This is simply an impossibility; a tube may perhaps add to a tone that of itself possesses a power of 100, so that the tone may have a power of 110, or it may take away from the tone to the same extent, reducing it to 90. The sound is never destroyed by a resonator.

The devices that Edison used are not any more subject to this objection than were Bell's.

There is not one instance among all these numerous exhibits of Bell that does not contain a resonator. Even his second patent, which was not applied for until 1877, had a big trumped E, more like a dish horn than the telephone of to-day. No, Mr. Bell, it is best to say nothing about Edison's devices being resonators. You have never shown any device or model without a resonator.

Edison's devices without resonators are numerous, see articulating transmitter and all the instruments introduced by Push, Prescott, Wiley, and others.

Edison, p. 16, says these instruments gave out all tones; in this he is corroborated by Johnson, Bell, Batchelor, Bentley, Push, Spice, Wiley, Scott, and others.

If the resonators had picked out each its own tone only, the musical telegraph would have been perfect in 1875. But because no resonator has ever been made which did not respond to other than its own tone, the musical telegraph has made but little advance. Even Mr. Bell used in end of 1875, and afterwards, a box, with a hole in it, to listen at; he covered up hole shown on page 86, Vol. 2, David Record, and was so foolish as to afterwards add a trumpet or fish horn as in his second patent; Mr. Bell had better not say anything about Edison's device A and A' being resonators; these were made and used in 1875, and Bell adds a resonator like a fish horn, in the end of 1876.

Counsel for Bell contends, in his printed argument, that the questions involved are to be regarded as a whole, and if Bell first did transmit speech then he must be regarded as entitled to all the devices that every person had before made that would transmit speech.

The fallacy of this position will be apparent.

Watson (p. 721, vol. 3) says Bell first tried speech June or July, 1875. Reis had transmitted some speech in 1861. There is no evidence that Bell's 1875 device was adapted to all speech; on the contrary, the accounts given (p. 71, Prescott's work) say this was unsatisfactory. This was the statement at a lecture before the Society of Telegraphic Engineers given by Bell in October, 1877. It was not until after all Edison's present cases had been filed that it was discovered that Bell should have told a different story, and Watson (p. 722) corrected Bell, or rather wanted him to make out a different story from the facts. This was in 1878-9.

Watson says (p. 722) that before the end of 1877, Bell had only made two instruments such as figure 7 of Bell's first patent. Page 725, Watson tells us that the battery was discarded in 1876 and not used again until November, 1878, after the Blake (so-called) was seized upon by the Bell Company. Then (p. 726) we are told that the Bell Company has 600-

000 circuits with batteries in them, and (X. 71) Watson says battery transmission is the best. Now for counsel to contend that the subject has to be considered as a whole, that there is but one invention and one mode of operation, is the most transparent folly, because here Bell drops the use of a battery for two years, and then admits that the system of to-day requires a battery. Does not that show change in the system? Does it not show that the question must be looked at in all its details *not* as a whole?

Counsel for Bell would desire that only one question should be considered, because that is the only way that the true issues can be mistified, and the only way that they can hope for success against Edison. Edison admits that Bell made a telephone in which a second armature was made to move by speaking against the first, and we have a right to ask that on the same principles of magnanimity Bell shall admit Edison to be the inventor of the Battery telephone. The two work as before explained on radically different principles, one—the Bell—on magnetic induction; he has a magneto-electric current inducer. Edison has a permanent battery current and rise and fall of electric energy—two distinct devices. Cross, page 748, states that the microphone and telephone are different. Edison has a microphone, hence it must be different.

Bell in his first patent shows how a battery may be used to induce magnetism, but beyond this his battery has nothing to do. He speaks of varying the current, but shows no useful way in which it could be done. Who has ever succeeded in moving the plates of a battery by a telephone or varying the power of a battery? He never did the thing; he gave up the battery for about two years; he never made anything useful. The public would not have had the battery telephones of to-day had it not been for Edison, and I ask your Honor to so rule in deciding this case.

Bell, in his statements in his first patent concu-

ing a battery, said no more than any school-boy could have said. He never did make any useful battery telephone, and the world would have been without the battery telephone of to-day had it not been for two years' hard work on the part of Edison.

The Bell specifications were his productions and he must be responsible for them.

You are asked to believe that the title in Edison's applications is of great importance.

Now Edison asks for patents on Improvements in Speaking Telegraphs (Cases 130-144), another for Acoustic Telegraphy, another for Improvements in Electric Telegraphy. The title is of no importance; all parties only improved on Reis telephone.

Bell and Gray sought to make telegraphs. Edison went beyond both parties with his closed circuit.

Bell has only five patents (page 739), and only the two now in question have been usefully employed.

What has Bell added to knowledge? nothing, but the magnetic induction.

Simple possession of the Bell patents is of no consequence in view of the early declarations of interferences, and the fact that the Bell patents were granted when other cases were in the office, such as Gray's Caveat, Edison's Caveats, &c., how the decisions in the courts also go for nothing, because the evidence in these interferences has never been before any court.

In drawing this argument to a conclusion, it is proper to direct the attention of your Honor to a few facts that throw light on the matter as a whole.

It is well-known that the introduction of the Stearns Duplex Telegraph created considerable excitement, and led to the transmission of messages in opposite directions simultaneously over the same wire.

By the Edison system of quadruplex telegraphy the number of messages and operators on one wire was again doubled. This was introduced in 1874, and produced great excitement in the electric fraternity, and efforts were made by rivals to

outdo the quadruplex. Mr. Gray, among others, tries his hand at the operation, and endeavors to produce a telegraph that will respond to numerous tones, so that messages might be sent musically.

This was also what Mr. Bell tried to do; it was an effort to outdo the Edison quadruplex.

As might be naturally presumed the West Un. Tel. Co., having possession of the quadruplex, did not desire rival companies to have any device that could compete with their quadruplex; hence Mr. Orton, in June, 1875, called Edison's attention to the acoustic telegraphs that had before existed, such as the Reis telephone. Thus it will be seen that the Edison quadruplex telegraph was the motive force that stirred up Bell and Gray and others. These again stirred up Edison in connection with acoustic telegraphs. He, Edison, operating rapidly and being very energetic, brought out several successful acoustic telegraphs, which have been patented and are the exhibits in these interferences, and he steps into the domain of the telephone for transmitting speech; he makes devices some of which were primarily intended for acoustic telegraphs, but which really were adapted to act as receivers and reproducers of any kinds of sounds. This was a great step in the proper direction; then in his efforts to transmit musical sounds he made devices that actually did transmit other sounds, and which laid the foundations for the telephone of to-day.

It will also be found that the Bell *magneto* transmitters and receivers were put into use in a manner to interfere with local telegraph lines; this was likely to be detrimental to the Gold & Stock Telegraph Company, with whom Edison had a contract. In 1877 it was discovered that the Bell magneto instruments were very sensitive to external inductive influences, and in the same year Edison had made his carbon transmitters, which were found to be a great success and not so much influenced by induced currents from adjacent lines. This in return, during 1878, produced a reaction against the Bell

Company and in favor of Gold & Stock Company, and threatened to greatly derange the Bell Company, and when the so-called Blake transmitter was presented to the Bell Company the latter part of 1878, it was eagerly grasped at, and these instruments were put out as rapidly as they could be made. The complications at that time were such, and the rivalry between the two companies were so great, that business prudence suggested compromise, which was finally effected, the Bell Company taking the management of the business and the Gold & Stock a compensation. This result has been attained during these interferences.

In the progress of these proceedings, evidence had been submitted showing the introduction of a great number of the Blake carbon transmitters, and it had the appearance of an effort to depreciate the value and importance of the Edison carbon transmitter; it appeared therefore necessary to introduce rebutting evidence showing the merits of the Edison transmitter in comparison with the Blake. By this it will be found that where the two instruments have been used side by side, the preference is given to Edison's instrument, for perfect articulation and reliability in the adjustment.

It is to be understood that Edison did not cease his labors until he had attained the greatest perfection in the actual transmission and reception of articulate speech. Numerous changes have been made in the appliances connected in the system, but the instruments of to-day do not give any clearer sounds than those made by Edison.

Edison began his inventions in telephony by conceiving that it was necessary to use a closed circuit and to pulsate the current by a resistance in that circuit; that was his primary idea; and it has been his method from first to last, and in that he has succeeded. Edison has not built upon the method that another had before invented, but has pursued his own method, and is entitled to protection in all the devices that have been made in developing and perfecting that method.

Bell's first use of an iron diaphragm, page 612, Vol. 2, April, '76, was six months after Exhibit A, A' were used.

Bell's second patent is *not* for a method, but for devices, and those devices were made practically by Edison six to eight months before Bell.

Bell evidence, 715, Vol. 3; 661, 662, show end of 1875, as time of inventing device in Bell's second patent.

Edison had iron diaphragm A, A' in 1875, see also caveat 75, and sketch, p. 577 of his record.

Edison did not testify into the Dowd suit, and his inventions were not referred to therein. The reasons do not appear, he must not be bound by anything therein, as he was no party to the proceedings directly or indirectly.

The previous evidence of Prof. Morton in a suit was put in as a whole, and Edison had only benefit of cross-examination, and that brought out the important evidence to which you have been referred.

Edison did not have a circuit breaker—this is admitted by all parties—he is first on this feature. In case 148 there is no break. These devices in 148 were reduced to practice November, 1875.

Bell did not attempt to do the same thing until a year later. Points in mercury cup in Edison's 148 kept circuit closed, and reproduced sounds accurately as to pitch and quality.

Gray could not do this, and never did do it.

Counsel for Bell has admitted that in Edison 148, all sounds could be reproduced as to pitch and quality; hence further answer to argument in behalf of Bell is unnecessary, as Edison antedates Bell with the devices of 148 about a year.

Case G, is not in Edison's application No. 148 and Edison is first in this count. The devices shown in this application No. 148, are not limited as to mode of transmission.

Edison had all the conditions of a closed circuit, necessary to produce a telephonic receiver in case 148, and nothing more was needed to make the re-

ceiver of the present day; this is substantially admitted by counsel for Bell.

Bell's patent (14) Fig. 7, may be regarded as only spoken of in connection with singing, 30th claim may be read as referring to music.

Bell's patent does not point out differences between his method and the Reis method.

Devices of Bell's 2d claim were never used and are valueless.

Bell's English specification 87, Vol. 2. Dowd suit prepared by him a year after the specification of his first patent, shows that he was vainly feeling after something, he knew not what was necessary for success—and this is commended to your Honor's perusal as showing how far Bell had gone at this time. He sets forth the transmission and reception of telegraphic signals electrically, and only refers to the noise incidentally. Let him have what he invented, but don't let his devices stand in the way of my client having what belongs to him.

Carlson and weight something that Voelker did not have. These belong to Edison. Voelker's counsel has so admitted, and on these alone success has depended.

IS REGARD TO McDONOUGH'S CLAIM

There must be some place where success and failure begin and end.

Reis sometimes heard words.

No doubt he did.

You draw a line, and write one side "success" the other "failure."

Success

Failure.

The line must be a division.

You cannot have success and failure at the same time any more than you can have a stone go up at the same time it comes down.

I have illustrated it in this argument that the more nearly the devices approach to an absolute unbroken current the more perfect the telephone.

The phonograph demonstrates that if the point is not set down deep enough many tones are imperfect. Now success does not so much result from an accident, it results from a premeditated intention or an intelligent appreciation.

Permit me to give an illustration from a case that came under my own observation.

Electro magnets, to compensate static charge and discharge, are used to cut off tailings in the automatic system.

A Mr. George Little put a magnet in a line as a resistance only; the tailings were cut off. This magnet was taken out the next morning because a proper rheostat had been received. The tailings reappeared; it was supposed to result from outside conditions. It was six months after that Edison, after experiment, put an electro magnet in line for the express purpose of cutting off tailings; it did the work, and he patented it. Little came to me with complaint; said he had done the same thing—true—but he did not know it; he did not know what produced the results. Edison was the inventor, because he had an intelligent idea of what was wanted to be done. To adjust a telephone is perhaps to put the apparatus over the line from failure to success.

McDonough attempts this adjustment in 1878, after all Edison's interfering applications had been filed. Voelker never made any such adjustment; he adjusted to break circuit, as his evidence shows.

Reis never contemplated such mode of operation as to keep the circuit closed.

The knowledge of the manner of using the Bell instrument for speech is not set forth in his first patent.

McDonough's instrument never did have success, and he did not understand the principles involved.

Bell, McDonough and Voelker must be condemned; McDonough for his ignorance, Voelker for lack of knowledge, Bell for failure to state what is necessary for practical operation.

Evidence must be examined carefully to see what the party actually had and did at the time the views were got up, and the state of the art at that time has to be carefully weighed.

What Mr. Gray, Mr. Bell or Mr. Edison had, must be regarded in the light of *what each was seeking to do*.

Bell and Gray were seeking to make a substitute for the Edison quadruplex. Edison was endeavoring to improve on his own device both as a musical telegraph and a speaking telephone.

The musical or acoustic telegraph was the thing that was pursued at the first most diligently in behalf of Western Union Telegraph Company.

Then the telephone was pursued almost exclusively.

Bell is a man of fine appearance, fluent speech, persuasive manners.

By his ability he so impressed himself as to obtain permission to use his telephonic apparatus to locate the ball in the body of our late beloved President. He located it, and his powers of persuasion were such, that when the surgeons placed their fingers on the places indicated they KNEW the place of the ball; but, alas! the surgeon's knife revealed the fact that the ball was, at least, fifteen inches away from the place where Professor Bell, with a flourish of trumpets all over the world, had located it.

Mr. Bell is not here to locate the place of his own invention to your Honors, but he is represented by learned, eloquent counsel, that carry great weight even personally; they will seek with great eloquence and ability and with their array of instruments to locate the invention of Mr. Bell and point to the spot, and, as it were, desire your Honors to put your fingers on it. Well, perhaps, we may now be deceived by the eloquence and persuasive character of counsel; but when your Honors put in the knife of clear judgment and dissect the evidence, it will be found that the invention of Mr. Bell is not where it

has been pointed out—it is much *more than fifteen inches* away.

It is believed that if other parties had been as frank as Edison it would have been admitted that Bell was entitled to the *induction* transmission and reception of sounds.

Edison was the first to employ useful devices in a *closed circuit*, in which there was not any induction.

Neither Bell, nor Gray, nor Dolbear, nor Voeckler had the closed circuit battery telephone.

Edison alone had, and succeeded in using a rise and fall in a closed circuit, and he alone is entitled to that feature in a telephone; and to all things therein connected; he is also the first to have made an instrument Ex. A, which is the telephone receiver to-day, and he used it in a closed circuit with rise and fall of tension. Commencing in 1873, Edison goes on step by step; he has all the principles of closed circuit in 1875; he avails of that in the quadruplex in 1874. He goes on in 1875 and puts Reis and the water relay together. In 1873 he has a carbon resistance for an artificial Atlantic cable; it was so very delicate that it could not be used, because it varied by the shake in walking across the floor near it.

He goes on, makes Exhibits A A', and the device Ex. B, November, 1875—just the same as his application 145. These all are in the line of the efforts of Edison from the first with closed circuit. The instruments of Edison have gone generally into use. Where is there one of the Gray instruments that was ever used as a telephone? Voeckers has added nothing to the art; there is not a word of evidence that he ever went so far as to get that which could be used.

Who would use a sheet of brass two feet long to listen to, as he did, or an instrument in which holes were punched by the point in the transmitter. This would constantly require to be repaired.

Every one of the counsel that has argued this case

at the former hearing made use of my client, Edison's, efforts to belittle the efforts of other contestants.

I thank them for their statements in this respect. Bro. Smith used Edison to overthrow Mr. Voelker and Mr. McDonough, while arguing against Edison and in favor of Bell.

Counsel for McDonough referred to what Edison has done as against Bell.

Counsel for Voelker and Irwin need Edison's efforts to demonstrate that Bell's patent is not for the telephone of to-day.

While thanking these gentlemen for their kindness, permit me to say that *Edison is the only one who has been able to stand on his own foundation, and who has not had occasion to use one of his contestants to defeat another, and hence is in a better position than any of his opponents.*

It may be asked where are there any of either Voelker's or Irwin's instruments in actual use.

Where is the Gray transmitter; has it been useful to the public?

Where are there any Dolbear or McDonough instruments in use?

The evidence fails to show any.

The Bell magneto transmitter, which Edison acknowledges to be his, and the Edison carbon transmitter are the only two useful transmitter instruments of to-day. Others have polished them up—added details, but the foundation remains.

The receiver with the magnet and iron diaphragm and a case is Edison's, and it is an improvement on the Reis. All the useful battery telephone instruments of to-day are based on the Edison mode of operation heretofore referred to as the closed circuit and varying resistance.

The method adopted by Edison varies from that of Bell and others in the following particulars:

If an armature be withdrawn from a magnet a current will be set up in one direction in a helix surrounding the poles of that magnet; when the

armature is moving towards the magnet the current will be in the opposite direction. This is an old and well-known law that is availed of in every magneto and dynamo electric machine that has ever been made; and it is the principle of Bell and Dolbear, and also of Gray, previous to 1876.

It makes no difference whether the magnet is a permanent steel one or an electro-magnet, except that in the latter instance there is a current to maintain the magnetism.

With a permanent magnet, if a galvanometer was placed in a circuit to the helix the needle would move first one way and then the other as the armature was moved towards and from the poles of the magnets. If a galvanometer is introduced in the same manner into the circuit to the helix of an electro magnet, the needle will be deflected to a certain degree by the normal current from a battery which produces the magnetism, but the needle will swing each way from that point as the armature is vibrated before the magnet, the same as before stated.

This action is due to a secondary current that is induced in the helix by the movement of the armature. In the first Bell instruments the diaphragm was distinct from but connected to the armature; subsequently the diaphragm was used both as diaphragm and armature. The method of operation of the Bell magneto transmitters and receivers remains unchanged to this day and is on the principles just stated.

The transmitters of the Reis type all operate upon the same principle as a telegraph key, viz.,—putting on and taking off a current; that is the kind of instrument that Voelkers and McDonough experimented with. It was also used by La Cour, of Copenhagen, and others, and it has been shown clearly that this system cannot be used for articulation. The tones and wind-rushes in speech are, not measured by time and cadence, but speech may be regarded as relative volumes in the utterance of sounds.

The same words can be said or sung in a high pitch or a low; the words are not distinguished by the pitch, but by the relative volumes. These differences are pointed out in the testimony of Cross, Johnson, Morton and others, and are illustrated by Ex. 27 and 28, Vol. 2, Dowd suits.

Edison appreciated the fact that the induced current of the Bell method had a limit, and was liable to be interfered with by other induced currents on the line; he therefore struck out on a method of his own.

By observing the curves in the aforesaid exhibits it will be seen that articulate speech produces very irregular lines, while music produces regular waves.

Suppose a phonograph foil to be cut through the line of indentations without injuring them and magnified, we may have a line thus:

No. 1.

Suppose the strength of current in a magneto telephone to be represented by the thickness of the line, the current is strongest when motion of diaphragm is fastest, viz.: In the middle and one current will be +, the next minus, thus:

No. 2.

Now, with the carbon transmitter the current is the greatest when the pressure is greatest and there are not plus and minus currents. The diagram would be thus:

(No. 3.)

With the instruments like the Reis, that break contact at extremes of movement, the diagram would be thus:

There being places where there is a break, the same as would occur in the phonograph if the point did not touch the foil, there is no rise or fall of electric energy.

Edison conceived the idea of the battery telephone of to-day, when in June, 1875, he proposed to combine the Reis magneto receiver with his water relay, patented in 1873.

Now, what was this invention? To illustrate, suppose I have a pipe, through it water is flowing. To entirely stop the flow would be to defeat the object sought; there would be inertia to be overcome, and false drippings at the delivery end; but to press with more or less force on the rubber tube through which that water was flowing would cause the constant running stream to vibrate without being stopped, and all the difficulties incident to stopping and starting would be avoided.

Edison knew that to *stop* the electric current would be to produce a change of electric condition on the line which is from maximum to nothing, like the action of a telegraph key; his quadruplex showed these facts: it was necessary then to have a constant current on line. Edison set himself to work to simply vary the electric current without interrupting it. All his efforts were in this direction; it was a task not easily accomplished: device after device was tried, and finally carbon, which he had used as a resistance as far back as 1873 (see Ex. Carbon Rheostat, page 517, Vol. 2), was found the best, to be inserted in the electric circuit, to be pressed upon more or less by the movements of the diaphragm, and either dam up or allow to move more freely the current without interrupting it. This is Edison's method, and it has not been employed by any one else before him, and he is entitled to the broadest claims possible, and also to claim to all the devices that formed steps up to this successful issue.

The telephone of to-day appears very simple and easily invented, but two year's hard, constant work, brought it out, and but for Edison's carbon transmitter, the entire system would have fallen short of anything generally available, commercially.

This carbon transmitter was the top stone in his telephonic temple of fame, and every step that he laid up to that top stone is his, whether carried out in the minute particulars or not.

It is true some of the steps were rough, still they were steps; and because some other person, such as Blake, may stop to polish up some of these steps, he is not to be permitted to claim the step itself which was selected and laid in place in the temple of fame that has been erected by my client.

We ask, therefore, a decision in favor of T. A. Edison, client on all the points claimed in this brief.

LEWEL W. SERRELL,

Attorney for Thomas A. Edison.

HOSCOE COXKLE,
Of Counsel.

IN THE UNITED STATES PATENT OFFICE.

THE

SPEAKING TELEPHONE INTERFERENCES.

DECISIONS OF THE EXAMINERS-IN-CHIEF.

CASES A, B, C, D, E, F, G, H, I, J, AND NO. 1.

No. 8123.

VOELKER }
v. } In re. Interference.
GRAY et al }

CAGEs A, B, C, D, E, F, G, I, J, L, and No. 1.

SUBJECT-MATTER: TELEPHONES.

This interference involves the invention of the speaking telephone, and was originally divided into Cases A to L and No. 1. Cases H and K do not now exist, having been merged respectively into F and I.

Of the fourteen original parties there remain now only six, viz, William L. Voelker (two applications), Thomas A. Edison (five applications), Elihu Gray (four applications), John H. Irwin, James W. McDonough (one application each), and Alexander Graham Bell (two patents).

The examiner of interferences has awarded priority of invention to Bell in Cases *A, B, C, E, F, I, J*, and *L*; in Cases *D* and *No. 1* to Edison, and in Case *G* to McDonough.

From this decision Edison has appealed in Cases A, B, C, E, G, J, and L; Voelker in Cases A, B, and No. 1; Bell and Gray in Case G; and Irwin in Case No. 1.

There is no contest here as to Cases *D*, *F*, and *I*, appeal not having been taken by the unsuccessful parties to them.

The history of the art, the devices covered by the issues, and the testimony have all been so exhaustively considered by the examiner of interferences that for us it simply remains to take up the issues in order, considering in detail only those portions of the evidence which are relied upon by the contestants and the examiner, and indicate wherein we agree with or differ from his conclusions.

Bell is the only one of the contestants having patents. Of these, his first, granted March 7, 1876, has been vigorously attacked upon the ground that it does not disclose the invention in controversy, but this question has already been determined; by the office, when the patent was granted, when the interference was declared, and when, in *Bell v. Gray C. D.*, 1879, 42, the Commissioner defined the various issues; and by the courts, in *American Bell Telephone Company v. Spencer*, 8 Fed. Rep., 509; and *Stane v. Dulleah*, 15 *Id.*, 418. It is not now required to be considered by this tribunal as open.

Neither will it be necessary for Bell to prove reduction to practice. Having a patent the law presumes that his invention was complete when he filed his application describing it.

In *Wheeler v. Chenoweth et al. C. D.*, 1869, 43, which was an interference between two patents and an application, Commissioner Fisher said:

"It must be assumed that Wheeler's invention has passed beyond the region of experiment. It has been patented, and has, therefore, in the judgment of the office, been reduced to a practicable, useful form. It is a perfected and completed invention."

In *Hannmond v. Laidl C. D.*, 1875, 23, Commissioner Thacher, after stating this rule, thus indicates its limits:

"The reason of this rule is apparent; it is a fatal objection to an application for letters patent that the specification does not describe a complete and practicable apparatus; and when a patent is duly granted, it is presumptive evidence that the requisite facts existed upon which the issuing of it was conditioned." (*Patterson v. Holland*, 1 Fish, 332; *Cahoon v. Ring*, *Id.*, 397.)

So also Acting Commissioner Doolittle, in *Bush v. Phelps C. D.*, 1876, 119:

"The grant of a patent having once been perfected, the inventor has fulfilled his part by the contract, and the public are put in possession of a full and complete knowledge of the invention; and it matters not whether he has reduced the invention to

practice, for the grant itself supplies the place of such embodiment." (See also *Dane v. Chicago Manufacturing Company*, 20 O. G., 677; and *Wing v. Richardson*, 2 Fisher, 545.)

In *Huntley v. Smith C. D.*, 1880, 182, it was held by Commissioner Marble that even in the case of an interference between applications, the filing of an application is evidence of completed invention.

"The reason assigned for refusing the motion," says the Commissioner "to wit, that the filing of an application does not amount to a reduction to practice, does not seem to be logical. It is true that the filing of an application does not prove reduction to practice, but because it does not prove reduction to practice, it does not follow that such application fails to establish the fact of invention. Indeed, it would seem to be the strongest proof possible of the fact of invention at the date of application, provided the disclosure was so full and complete as to enable others skilled in the art to which it appertains to make and use the same or such as to furnish the basis of a patent having the legal requirements as to disclosure. * * * No condition of reduction to practice is called for by the statute. * * * The courts have in no case, so far as I am aware, held that an application diligently presented is not evidence of invention at the date of application of the invention therein disclosed."

In *Starr et al. v. Farmer, C. D.*, 1883, 34, which was also an interference between two applications, Commissioner Marble made a similar ruling:

"The reduction to practice," said he, "may be better evidence of invention than an application, and it may be a necessary element of title in some or all cases; but the evidence furnished by the application is all that is required by law to establish the existence of the invention, at least as early as the date of filing for the purposes of examination, and for the purpose of granting a patent thereon, and until that evidence is overturned and some prior invention brought to view, the applicant is not called upon to furnish any better."

This decision of the Commissioner was affirmed upon appeal to the Secretary of the Interior, *C. D.*, 1883, 116. In his decision the Secretary says:

"Where an original discoverer has made a formal application for a patent in conformity with the requirements of the law, has furnished a description of the invention, which, with the drawings * * * is a sufficient disclosure to a person skilled in the art of the practical utility of an invention which in other respects is patentable, and has received by diligent prosecution of his application a faith in its importance, it is not necessary, to en-

title him to be considered an inventor, that he shall prove actual reduction to practice. It is enough if he has shown in the manner prescribed in the law that the invention is perfect and capable of useful operation."

"It being, then, a well-established principle that a patented invention is presumed to have been completed at the time the application was filed, it is also well settled that in order to overcome this presumption the proof must be such as to invalidate the patent *in suo*. To effect this the parties attacking the patent must show either that they had first made and reduced the invention to practice, or that they had first conceived, and were at the time the patent was granted using reasonable diligence to reduce to practice and actually accomplished such reduction. The character of the proof required by the office is clearly indicated in the decisions.

"All the presumptions and doubts are to be resolved in favor of the patentee." *Cushman v. Parham*, C. D., 1876, 130.

"As two patents ought not, if possible, to be granted for the same invention, the benefit of the doubt, if any exists, should be given, not to the last applicant, but to the patentee." *Wheeler v. Chermoreth*, C. D., 1869, 43.

"The burden of proof is upon the latter (the junior applicant), and he must show that he had reduced this invention to a completed form prior to the invention of the same by the patentee, and this too beyond all doubt." *McKnight v. Van Wageningen*, C. D., 1876, 127.

In *Richardson v. Dunn*, C. D., 1870, 156, the earliest published decision of the office upon this question, Commissioner Fisher said:

"In this case Richardson has a patent, and the real question is whether one shall also issue to Dunn. The burden of proof is upon him to show priority of invention, and this proof should be substantially of such a character as would suffice to defeat the patent of Richardson if it were in suit before a court of law. The well-settled doctrine of the courts is that he who would prove that a patented invention is wanting in novelty must show that the invention upon which he relies has actually been reduced to practice prior to the invention of the patentee."

To the same effect is the language of Commissioner Leggett in *Morse v. Clark*, C. D., 1872, 58:

"To invalidate a patent already granted, following the analogy of vested rights of other kinds, the courts have held with great uniformity that prior invention must be established by the high-

est possible class of testimony, viz, working machinery. In such cases the working machinery must anticipate, not the date of the patent merely, but the date of the patentee's invention."

In *Gray v. Hall*, C. D., 1871, 129, Acting Commissioner Dunn, in an exhaustive review of the case bearing upon this point, says:

"The list of cases in which the same doctrine has been laid down could be largely increased, but the above citations are sufficient to show that nothing short of a complete and successful prior reduction of the invention to practice by another than the patentee can avail before the courts to defeat an existing patent. *A fortiori* must the invention have been reduced to a successful practical form to justify the Commissioner of Patents in issuing a new patent of such character as to control those already granted; for such a grant not only places the existing patentee and all persons interested with them, no matter how vast their investments of capital, entirely at the mercy of the new grantee, but is operative also against the public at large."

In *Bush v. Phelps*, above quoted, it was said:

"In order to enable an applicant to succeed in defeating the title already conferred he must show that he was either the first to conceive of the invention and was using reasonable diligence in reducing the same to practice, or that he was the first to practically embody the invention; while the patentee, though first to conceive, did not with reasonable diligence either perfect his invention or apply for a patent. The patent itself is regarded in the courts as *prima facie* evidence that it describes the invention of the patentee." (*Wheeler v. Clipping Mower and Reaper Company*, 6 Fisher, 1.)

To the same effect is the ruling of Commissioner Spear in *Stoner v. Clark*, C. D., 1877, 92, and *Towers v. Pease*, C. D., 1878, 6.

"In this class of cases the adverse applicant must show conclusively that prior to the time of the invention by the patentee he (the applicant) had fully reduced it to a form or condition capable of standing the test of actual practical use."

Pease stands before the office and the country as a patentee. In order to make out his title to a patent Towers would be compelled to show that he had been first to make the invention, and that he had reduced it to practice before the grant of the patent, or was following it up with reasonable diligence."

In *Sargent v. Burge*, C. D., 1877, 92, the same Commissioner, in speaking of an applicant contesting a patentee, says:

"It is here * * * as an applicant for a patent seeking to overthrow a patent where the invention in controversy has

not only been patented by an opponent, but put into the market as an article of sale, and subjected to the test of actual use in a large number of instances prior to his application. Here the presumption is altogether against him. He must remove all doubt as to his alleged invention and show that it was complete, not merely as an experiment and for temporary and experimental use, but that it was actually reduced to such form as to be capable of successful use prior to the invention of his adversary. The successful use of the invention involves not only its successful mechanical operation in the single instance, or in a number of instances, but its actual utility in every other respect."

To show that these decisions of the office are in accord with those of the courts, it is necessary to cite only *Ellithorpe v. Robertson*, 2 Fisher, 83; and *Union Sugar Refinery v. Mathieson*, 30, 625; in which it was said respectively:

"To constitute such a prior invention as will avoid a patent that has been granted, it must be made to appear that some one before the patentee not only conceived the idea of doing what the patentee has done, but also that he has reduced his idea to practice and embodied it in some practical and useful form. The idea must have been carried into practical operation."

"Settled rule is that it is not enough to defeat a patent already issued that another previously conceived the possibility of effecting what the patentee has accomplished, unless it also appears that he reduced what he conceived to practice in the form of an operative machine. To constitute a prior invention, the party alleging to have produced it must have proceeded as far as to have reduced his idea to practice and embodied it in some distinct form. Consequently, you are instructed if what you find to have been done by any one before the date of the patented invention, as established by the evidence, did not amount to a successful reduction to practice of the mode of operation described and claimed in the patent, * * * then such prior acts or experiments do not have the effect to invalidate the patent."

This citation of authorities has been thought necessary, in view of the position taken by counsel for Edison, that in order to entitle him to priority his embodiment of the invention need not have been either operated or operative, provided he comprehended its principle and can now show it to be operative; and from them it is clear, first, that Bell, standing as he does upon his patent, is to be given the date of filing his application as the date of his invention; secondly, that no further proof will be required of him unless the evidence of his antagonists shall have overcome this date; and thirdly, that such evidence to be effective

must show anterior, complete, and successful embodiment of the alleged prior inventions.

It may, however, before taking up the issues, be well to consider in a general way the positions of the parties to this proceeding. Bell is not only a patentee, but it is to him that the world owes the possession of the speaking telephone. Whether he first invented it or not, and leaving his patent out of consideration, it is undoubtedly true that he was first to describe and put it into the hands of the public. Upon May 10, 1876, he read a paper before the American Academy of Arts and Sciences in which it was described. It was exhibited by him at the Centennial Exposition at Philadelphia, and upon June 25 was successfully operated before the judges of the proper section and many other persons. Following this, descriptions of it were published in the newspapers of this and foreign countries; it was publicly exhibited before popular audiences and scientific bodies, and to Bell was generally ascribed its invention.

In the prosecution of his invention he was busy during the year 1876, and January 15, 1877 he filed his application for improvements upon (among others) the telephone apparatus of his patent of March 7, 1876, which was patented January 30, 1877. In the spring of 1877 an arrangement was made by which the public was to be supplied with telephones; a line for telephonic transmission was built between Boston and Somerville; between April 20 and 20 two other lines were built in Boston; in May circulars announcing that the proprietors of the telephone were ready to supply the public were issued, and between this time and October 30, 1877, about 3,000 had gone into use.

During all this time not one of Bell's present competitors had made any public assertion of a prior right to the discovery of the art of transmitting speech, or had sought to correct the error into which the world had fallen. On the contrary, Gray, who had previously filed a caveat in the Patent Office, and who was present and assisted at Bell's exhibition at Philadelphia (Gray, X-A, 108), and the same evening called upon him at his rooms, not only did not dispute Bell's right (Bell, A, 141; Hubbard, W. H., A. 11), but now admits that with Bell's instruments at that time he obtained the "nearest approximation to articulate speech he had ever heard" (Gray, X-A, 109). He also, in a public lecture

are delivered in Chicago, February 20, 1877, as he himself writes to Bell (Gray, X-A. 147), gave him "full credit for the talking feature of the telephone," and in a lecture delivered in New York this likewise. Of his four applications involved in this interference, the earliest of them was not filed until more than nineteen months after the date of Bell's patent and sixteen months after he had listened to Bell's instruments at Philadelphia.

As to Edison, although his assistant, Johnson, exhibited his telephone publicly in various places in the summer and fall of 1877, no claim was made at any of these exhibitions that he had invented the art or anything more than a means of practicing it. His earliest application was not filed until April 27th, 1877, more than a year after the date of Bell's patent, and nine months after his knowledge of Bell's Philadelphia exhibition (X-A. 202).

Voelcker's applications were not filed for more than three years after the grant of Bell's patent, nor were his claims put forward until the telephone had gone into extensive public use.

McMahon is the only party not chargeable with delay and knowledge of Bell's public exhibitions, as his application was filed only about a month after Bell's patent had issued.

It is true, the general recognition of Bell's claims to inventorship, the long silence of alleged prior inventors, and the introduction of the telephone by him into public use, do not prove his case, for these may have been only the result of superior activity and enterprise. They are nevertheless facts which have a material bearing upon the issue here, as like facts have had in other similar cases. If Bell be the prior inventor, his history is only that of many other pioneers in the advance of science and the mechanical arts.

See the court in *Hovoe, Underwood*, 1 Fisher, 160, in which the invention of the sewing-machine was involved:

"How invariable it is that after a great invention has been brought before the world, has become known to the public, and been put in a form to be useful, that people start up in various places and declare that they invented the same thing long before."

"These pretended prior inventors had thought of such a thing; they had the conception of such a thing perhaps, but they had never carried it to the extent of making it of practical utility so that the world could obtain possession of it. But when they find that another has completed that which they had

begun they are astonished that they did not see, think they must have seen all that is necessary, and claim that they have invented it. After having seen what has been done, the mind is very apt to blend the subsequent information with prior recollections and confuse them together."

It is this tendency of the human mind which has led the courts to hold those seeking to overthrow patents to strict proof of actual and successful prior embodiment, and the office to apply the same rule to those asking a patent for that which has already been patented to another.

In this case the rule of the office is to be applied with strictness, for Bell's patent has not only not been declared invalid by any court, but it has actually been sustained, and upon a record which is a part of the record here. It follows, therefore, that although satisfied from the evidence that Bell had made the invention before the filing of his application, it will not be necessary for the general purposes of this case to review those portions of it which have led to this conclusion. It will be sufficient to determine whether or not the other parties have overcome his record dates.

ISSUE A.

"The heretofore-described art of transmitting and reproducing at a distance sonorous waves or vibrations of any description, which consists in increasing and decreasing the strength of an electric current traversing a circuit in such a manner as to produce in said circuit a series of electrical waves or vibrations, precisely corresponding in their intervals of succession and relative amplitudes to the sonorous waves which are to be reproduced at the receiving station or stations, so that oral conversation or signals of any description may be telegraphically transmitted."

Bell, patent No. 174,465, March 7, 1876, application filed February 14, 1875.

Berliner, application, January 4, 1877.

Edison, application No. 130, April 27, 1877.

Richmond, application, August 24, 1877.

Gray, application No. 1, October 23, 1877.

Dalson, application, October 31, 1877.

Holcomb, application, January 18, 1878.

Voelcker, application, May 19, 1879.

This case, using in substance the language of the examiner of

interferences, involves the art of electrically transmitting and reproducing sounds having quality by converting the sound vibrations into electrical undulations and reconverting these into corresponding sound vibrations. The only parties to it here are Voelcker, Edison, and Bell.

As to Voelcker, his attention was not called to the subject of transmission of speech until November or December of 1875, when he had a conversation with Irvie. Even of the lover's telephone he was ignorant until after Christmas of that year, and his first experiment with anything of his own construction in the nature of a telephone was the latter part of February or the first of March, 1876. The results of this experiment were entirely unsatisfactory, amounting only to the "snapping and cracking of the armature of the receiver," and the transmission of one or two musical tones. The next instrument was not made by him until the following April, and its results were no better. (A. 6.)

Edison's case is very little stronger than Voelcker's. About 1872 he read an account of the Reis telephone, and in the summer of 1874 he had described to him an invention of Gray relating to harmonic telegraphy. He also in the winter of 1875 read Baile's *Elements of Electricity*. There being in this book some hint of the possibility of transmitting speech, he thought over methods by which the result might be attained, but did nothing further. In June or July following, President Orton of the Western Union Telegraph Company spoke to him of Gray's invention in acoustic telegraphy, and asked him to investigate the subject under contract with the company. The contract was not formally executed until December, 1875, but under a verbal agreement Edison began at once to experiment, and in July, 1876 made sketches of some devices he intended to experiment with (Edison's *Record*, vol. 2, page 502), upon one of the sheets of a translation given him by Orton of the *Legat* article on the Reis telephone.

There is no evidence except Edison's own that these sketches had anything to do with speech, and the most he can say for them is that they illustrated his rough ideas of what was necessary to make the Reis instrument an articulating transmitter. They were "notes for future use in experimentation," Hatcher, the only other witness who testified concerning

them, does not in any manner connect them with articulation (A. 9-12). He understood the sketches without explanation, because, he says, "we were working on instruments having that general principle." This, he it remarked, was in August or September, 1875, and, as even Edison does not claim that any speech-transmitting instrument was made before December of that year, it is only reasonable to suppose that Hatcher had in his mind acoustic telegraphy. This view is strengthened by the sketches themselves, for they show tuning-forks and resonators, and Hatcher testifies upon cross-examination that before he saw these sketches Edison was experimenting with tuning-forks and Helmholtz resonators, for the purpose of finding out "how much the resonator increased the volume of sound of the fork," and in every instance the resonator was one corresponding to the pitch of the fork. (X-A, 120, 121.)

It seems clear that these sketches furnish no evidence that Edison had conceived at that time how speech could be transmitted. Even granting that the lower figure, with its knife-edges connected by water, contains the germ of the variable resistance telephone, the sketches are merely indications of a line of experimentation to be followed at some future time.

Certain other exhibits made by him in 1875 are also of evidence. Those consist of sketches 6-9, 7-9, 8-9, 9-9, 10-9, 17-9, 22-9, and instruments A, A', all obviously relating to acoustic telegraphy, and all the sketches so labeled except 17-9. Edison, however, states that this sketch, as well as 8-9, shows a musical and not a speaking telephone (X-A, 221), and all the others show tuning-forks and resonators, or devices intended to be used with them. It is not necessary to consider these exhibits in detail. It is sufficient to say that none of them indicates a clear conception of the invention or would disclose to any one the method in controversy, nor did Edison himself successfully transmit articulate speech by the aid of these instruments which he actually constructed. He himself testifies that of all the trials with the voice which he made in November or December of 1875 "the results were uniformly unsatisfactory." (A. 31.)

It is also to be observed that Edison is not corroborated as to the experiments for the transmission of speech in 1875 by any of his witnesses, but all of them concur that it was acoustic telegraphy and not telephony upon which he was working. If

he was really experimenting upon speech in the fall and winter of 1875, it is strange that no witness is called who can testify to this fact. He tells us he conversed with a great many persons upon the subject, his laboratory was "a kind of a public place," and many people were about it while he was so engaged (A, 4). Of those mentioned, Batchelor, Reiff, Johnson, Kreusi, and Spice were called, Gilliland was not, and Charles Edison and Adams are dead.

Batchelor, although he describes the instruments used, does not anywhere say that speech was transmitted. His nearest approach to it is in answer to a question as to the adaptability of Exhilibits A and A', "to render audible acoustic vibrations of all kinds," in which he says that either is capable of doing so, and one or both of them was so used between November, 1875, and the spring of 1876. (A, 18.)

Reiff says the first knowledge he had of telephones was at Bell's exhibition at Philadelphia (X—A, 30). At Edison's shop he listened to the instruments A and A', and heard the Morse characters, the humming of the tuning-forks, and the sounds of the human voice, but cannot say that he heard words or that the voices he heard were transmitted through the wire. He does say that Edison was experimenting continuously after the latter part of the summer of 1875 until his removal to Menlo Park in March, 1876 upon the practicability of Gray's acoustic telegraph, and that the resurrector used took the place of Morse sounds. (A, 5.)

Johnson also is silent as to the transmission of speech. He frequently assisted Edison in his experiments and states that A and A' were used as analyzers of the sounds given to the wires by means of vibrating reeds, Morse keys, and vibrating electromagnets (A, 2-7). Here is clearly acoustic telegraphy.

Spice was employed by Edison as a specialist in that branch of acoustics embracing sympathetic resonances, which was of use to Edison only in telegraphy. There is not a word in his testimony relating to speech, but much as to tuning-forks and reeds, and he distinctly states that A and A' acted as Helmholtz resonators.

Kreusi's testimony does not bear upon this point at all. In addition to the testimony of these witnesses, there are several collateral circumstances which bear upon the objects of

Edison's work at this time. The most important is the contract entered into by him with the Western Union Telegraph Company. This contract was made December 14, 1875, to carry out the verbal agreement of July, 1875, with President Orton. The subject to which it relates is clearly set forth by name as "The Acoustic Telegraph" and as a system by which "not less than five or more distinct and separate messages can be transmitted on a single wire in opposite directions at the same time without interference with each other." It will be remembered that at the interview with Orton in July, Gray's inventions were spoken of and it was the stir which they were creating which led to Edison's employment. He was to investigate the subject and see if there was anything in it which would be useful to the company. How natural, then, that he should follow upon the road marked out by Gray, and this indeed is what Reiff says:

"Mr. Edison was experimenting to determine the practicability of acoustic telegraphy as it had been developed by Mr. Gray of Chicago." (A, 5.)

Two subsequent contracts were made between Edison and the Western Union Company, dated respectively March 22, 1877, and May 21, 1878. The first of these contracts relates to all Edison's "inventions and improvements capable to be used on land lines of telegraph, or upon cables, except chemical telegraphy." The second carefully distinguishes between the inventions made under the contract of December, 1875, and March, 1877, and it is a very significant fact that none of the speaking telephone inventions are recited as covered by the 1875 contract.

Exhibit 17-9 may also be referred to as showing that he was working upon the same line as Gray, for upon this sheet, which is acknowledged by Edison to represent a musical telephone, he wrote "instead of breaking the current like Gray threw in and out," &c.

It is also to be observed that all the sketches which are introduced by Edison as made in 1875, and the spring of 1876, are labeled Acoustic Telegraph, and it is not until we reach Exhibit 3-10, made July 6, 1876, that the words "Talking Telegraph" are used.

Great stress is laid upon Edison's patent 141777, and Exhilibits A, A', but these are insufficient as proofs of the invention of the matter at issue. The device shown in the patent is an

improvement in relay magnets, and is intended to prevent the burning out of the contact points, and do away with the necessity of adjusting the spring for retracting the armature. For this purpose the contact points are placed within a cell containing liquid, and are adjustable with reference to each other to vary the tension, so that when the point attached to the armature lever is moved toward the other point by the action of the relay magnet, and the tension is increased, the sounder magnet will operate its armature lever, but when the contact points are separated the tension will be diminished, the power of the sounder magnet loosened, and the armature retracted. It is true that variations in resistance are produced by this device, but they are effective only at the highest point of tension to attract the armature, or at the lowest, to be overcome by the force of the armature spring. There was here no idea of any such electrical undulations as are contemplated by the terms of the issue.

It is now stated by Edison that nothing was necessary to make a complete and operative telephone from this instrument but to add to the armature lever of the relay some means for concentrating the energy of sound waves upon it and to attach a diaphragm to the armature lever of the sounder (A. 20), but whether these changes would be effective or not for this purpose they were explained by him with the knowledge of the telephone he then possessed, and when he actually did adapt the cell of this patent to telephone purposes, as we shall presently see, nothing resulted but failure.

Exhibits A and A' are equally unsatisfactory. These exhibits consist of brass tubes, having at one end iron diaphragms before which were placed electro-magnets, and were intended as receivers for a system of acoustic multiplex telegraphy in which three different messages were sent simultaneously over the same wire. There was no transmission or reception of speech, but the different sound waves transmitted by vibrating reeds, three in this instance, were at the receivers broken up by a Morse key into definite intervals so as to form dots and dashes (Edison, A. 18). That they were used in experiments upon acoustic telegraphy there is no doubt. Edison's witnesses are clear upon this point, but they were nothing more than Helmholtz resonators. (Spice, X-A. 33.)

There is no testimony except Edison's own as to telephonic

experiments with these instruments. This is to the effect that in November and December of 1875 he took the cell of his patent No. 141777, added a stretched membrane to it, and put it in circuit with one of the receivers A, A'. This was the only attempt made in 1875 to carry out his original conception of the transmission of speech, and "the results obtained were entirely unsatisfactory" (A. 30-33), nor could it have been otherwise, for, as pointed out by the examiner, Edison at this time knew of no form of articulating transmitter, and the instruments which he states were capable of such use were not actually so used because he did not know how to use them.

Other instruments are stated by Edison to have been made and tried in 1875 which were adapted to the transmission of speech and which were afterwards so applied. (A. 33.) These instruments were constructed after the plan of sketches 6-8, 7-9, 9-9, 10-4, and "Exhibit Deposition of Battery, November 17, 1875," and need no further notice than that they were not constructed for speech transmission or so used at that time.

As to 1876, there is no evidence at all that prior to February 14 of that year Edison had any knowledge of any process by which articulate speech could be successfully transmitted or any instruments which did transmit it. The events filed in January by him all relate to acoustic or multiplex telegraphy and contain nothing whatever as to the transmission of speech, nor do the exhibits or instruments, which Edison says were made upon the plan of these events. Of his sketches, 3-10, dated July 8, 1876, is the first that relates in terms to this subject. It was made by Adams, now dead, and is merely a record of one of Adams's experiments. The date of "Exhibit Water Telephone," the earliest transmitter produced by him, is uncertain. Edison says it might have been made any time between December, 1875, and November, 1876 (A. 144), and Barteleer thinks Adams made it before October, 1876. (A. 23.)

Even so late as July 27 or 28, 1876, no instrument was made by Edison by which speech could be transmitted, for though he testified that an instrument (see Exhibit 73-10) made about that time was used for this purpose, the best he can say for it is that "you could tell that some one was talking, and if you knew what they were saying it sounded awful like what they were saying." This, it is to be observed, was a month after

Bell's successful exhibition at the Centennial and four months after the date of Bell's patent.

It is, to say the least, a coincidence that the first evidence which clearly and unmistakably shows attempts to construct a speaking telephone relates to events occurring in July, 1876, after Bell's exhibition and about the time of Johnson's account of it to Edison. Of all that was done precisely there is no certainty that any of it related to speech, but after this time the work was prosecuted diligently until it culminated in success.

There seems to be no doubt that Johnson gave the correct account of Edison's position in the telephonic art when, writing in his interest, he says that Edison—

"Taking up the subject of the transmission of articulate speech immediately after Bell's announcement of his achievement, and before he had yet made his device of practical value, soon distanced even Bell himself in the brilliancy of his discoveries, and in the practical application of the invention to the requirements of commerce." (Statement as to the Origin and Development of the Telephone, Johnson, 295.)

It may be well here to refer to Edison's own summing up of his claims to inventorship upon cross-examination.

"256. X-Q. When did you first attain the object of transmitting articulate speech with that degree of success which entitled you to consider yourself as having made that invention?"

"A. I think I conceived the invention in 1874. I made drawings of it in 1875. I reduced it to practice in December, 1875, but did not work satisfactorily because it was not loud enough."

"257. X-Q. When did you reduce that invention to practice with that degree of success which entitled you to consider yourself as having made it in a practical form?"

"A. It was in practical form in December, 1876. We did not make it work owing to peculiar conditions. The reason why I knew it was practical at that time is that since the present state of the art has been attained we have made instruments of that kind which worked satisfactorily as regards articulate speech, but not satisfactorily as to the volume of sound."

The conception here stated to have been made in 1874 is the vague idea which occurred to him in reading Baille's statement of the possibility of transmitting speech, that he might adapt the device shown in his patent 141777 to this purpose. This was not such a conception as the law requires. There was not in his mind "a well-defined idea of something which might

rightfully constitute the subject of a patent," which is the definition of a conception given in *Stevens v. Putnam*, C. D., 1880, 164. Besides we have already seen that when he attempted to carry out this idea he failed.

As to the practical form to which he had reduced it there is some doubt whether he means "Exhibit Water Telephone" or the electrolytic cell of his patent No. 141777. If he means the former, there is no evidence that it was in existence before December, 1876; if the latter, he obtained no practical results. His own answers carry with them their own denial: "It did not work satisfactorily," "we did not make it work." He does attempt to explain away these admissions, but only by after-acquired knowledge. "Prophecy after the event is easy prophecy." (Howe v. Underwood, *supra*.)

It must be concluded that Edison, like Voelker, has not overcome Bell's record dates as to Issue A.

ISSUE B.

"The heretofore-described improvement in the art of transmitting vocal sounds or spoken words telegraphically, which consists in throwing upon the line, through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air produced by a spoken word."

Bell, patent No. 174465, March 7, 1876.

Berliner, application January 4, 1877.

Edison, application No. 130, April 27, 1877.

Rishmann, application August 24, 1877.

Voelker, application May 19, 1878.

Issue B differs only in substance from Issue A in that the electrical impulses corresponding to the sound vibrations are produced through the medium of a varying resistance. The parties to it here are the same, and it is to be determined by the same considerations.

Voelker's case does not differ from that under Issue A and need not be further considered.

Edison's case, though based upon his application No. 130, which shows a disk of rubber or metal coated with plumbago, cannot rest upon this use of plumbago, for there is no certainty as to when it began. He states that experiments with it were

conducted at various intervals as near as he can remember from March, 1876, until 1877, and of the exhibits in evidence, "Exhibit October 12, 1876," bears its own date; 177-15 has no date, and Edison says it might have been made as early as April, 1876, or as late as March, 1877. Three other exhibit diagrams, 83-15, 80-15, and 81-15, he also produces, but says that it was impossible for him to state with certainty when they were made, but that it was either in March or April or in November, 1876. If these exhibits were completed inventions, such testimony as this would not suffice to give them a date prior to Bell's, but it is to be noted that at best they were only experiments which were taken up and laid aside at intervals under the stimulus of "getting sentences now and then that were said to be pretty good." (A, 57.)

Among the exhibits relied upon by Edison as to this issue are 6-4, 9-5, 10-5, and "Polarization of battery." They have all been considered under Issue A, and are no more pertinent to this issue than they were to that. Sketch 3-10 and "Exhibit Water Telephone" are also referred to; 3-10 is a sketch labeled "Experiments in Talking Telegraphs," and is described by Edison as consisting of a tube with a diaphragm, in front of which is a pillar carrying a contact point. Between the diaphragm and the contact point was placed a piece of felt saturated with water, salt and water, and other chemical liquids. The receiver used with this transmitter appears to have been a similar tube provided with a diaphragm and a magnet in front of it. Upon the sketch is written, "Get a good many words plain, such as, 'How do you do.'" This sketch was made by Adams, but its date, July 6, 1876, is too late to be of any avail here. It is mainly interesting as being the first sketch which relates in terms to speech transmission.

"Exhibit Water Telephone" is entitled to no more consideration, as its date is a matter of too great uncertainty. Edison states that "it might have been made in December, 1875, or any month between that time and November, 1876" (A, 144), and Batchelor that he first saw it "before Christmas, 1876." (A, 23.)

Edison's case, therefore, as to this issue must rest upon his liquid transmitter. This he tells us was made in December, 1875, and "consisted of a stretched membrane with a point of wire"

fastened to its center and immersed in electrolytic fluid, the "wire electrode being adjusted so as to be immediately opposite another electrode, the two separated by a short column of water." (A, 28.)

"This is the instrument which produced the eminently unsatisfactory results before spoken of, although it was constructed upon the plan of his original conception of what was necessary to transmit speech and of his explanation to Willard. (Willard, A, 3.) It does not appear what became of it after its trial, and no further experiments seem to have been made with it.

Seven reasons are assigned by Edison for this failure (A 32), which may or may not be sufficient to account for it, but they cannot avail to show that at that time he had any correct idea of the principle involved or how to apply it. The fact that afterwards and with the knowledge gained by the advance of the art he was able to construct a variable resistance telephone upon what he considers the same principle cannot lift this unsuccessful experiment into a completed invention. In this he occupies no better position than Reiss, for even his telephone, best as it was upon an incorrect theory, can now be made to speak.

Subsequently, in February or March of 1876, Edison states that he took up the subject of transmitting articulate speech, and the principle of variable resistance through liquid was experimented upon (A, 52), but nothing is produced which shows a satisfactory result. Indeed, it is not claimed by Edison himself that such a result was produced before June or July of that year with Exhibit 3-10, and as to this instrument he writes doubtfully says, "it was satisfactory so far as it went," but was not a "practical working telephone." (CX-A 259.) Even so late as September, 1876, an instrument made after sketch Exhibit 104-10 "did not work satisfactorily," and one made after Exhibit 102-10 only "worked to a sufficient degree to allow us to hope" (A, 62); and this, it is to be observed, was after Edison's knowledge of Bell's exhibition at the Centennial Exposition.

These last two exhibits are sketches contained in Gilliland's memorandum of August 2, 1876 (Edison's Record, vol. 2, pages 46-48). This document purports to be a record made by Gilliland of experiments upon speech transmission between May and August, 1876. It is not verified by Gilliland as he was not called, but its introduction was not objected to, and it may therefore be considered. (A, 52.)

There are two significant things in connection with this paper: first, that although Gilliland, and with him Adams, had been experimenting from May to August, 1876, it contains no mention of the successful transmission of speech, but only correct playing and singing; and second, that at its date, August 2, the liquid transmission is spoken of as "a plan which for want of perfect apparatus was not thoroughly tested." "A good model," it continues, "will be constructed, a thorough test made at once. A platinum wire is attached to the diaphragm and immersed in a solution or liquid resistance and the strength of the wave is by this means varied according to amplitude of the diaphragm."

A word may now be said as to the character of Edison's proofs, for here he labors under some disadvantages. Concerning various matters of which he testified he had no personal knowledge. His experiments were mostly conducted by assistants, as he himself was deaf, and as to some of the exhibits upon which he strongly relies, notably 3-10 and 50-15, his only knowledge is that conveyed by notes made by one of these assistants, Adams, who is now deaf; but even giving full effect to all the exhibits and experiments testified to by him, it is impossible to assign to him as to this issue an earlier date than Bell's.

ISSUE C.

Claim 1.—"The transmitter, consisting of the combination in an electric circuit of a diaphragm and a liquid or equivalent substance of high resistance, whereby the vibrations of the diaphragm cause variations in the resistance of the electric circuit, and consequently of the strength of the current traversing said circuit."

Claim 2.—"In a telegraph instrument operated by sound, the combination with the diaphragm of two or more electrodes placed in electrolytic liquid, and operating to increase and decrease the resistance of the electric circuit by the movement derived from the diaphragm."

Bell, patent No. 174465.

Richmond, application August 24, 1877.

Edison, application No. 144, September 5, 1877.

Gray, application No. 2, October 29, 1877.

This issue embraces two points, both covering the same substantial subject-matter, viz, a transmitter upon the principle of Issue B, in which through the medium of an interposed substance of high resistance the variations of the diaphragm produce

the variations in resistance. Claims 1 and 2 differ in that the former includes in terms a substance of high resistance, the equivalent of liquid, and the latter specifies two or more electrodes, differences which do not affect the issue. The parties here are Bell and Edison, and what has been said as to Issue B applies also here. Bell's record date has not been overcome.

ISSUE E.

"In an acoustic telegraph an armature plate, the electro-magnet for the same, and a closed circuit passing from the helix of such electro-magnet to the source of undulatory electric energy."

Bell, patent No. 174465.

Richmond, application August 24, 1877.

Gray, application No. 3, October 29, 1877.

Dilber, application October 31, 1877.

Edison, application No. 145, December 13, 1877.

Holcomb, application January 28, 1878.

The parties here are Bell and Edison.

This issue is in the language of the third claim of Edison's application No. 145, and its exact meaning has been a source of some difficulty. Counsel for Edison insist that the examiner of interferences has construed it to mean something else than that which Edison's application and claim embrace and to which his proof relates, but the examiner's construction, though somewhat broader than that given by the primary examiner and the Commissioner in Bell v. Gray, C. D. 1879, 42, does not so differ as materially to affect the result. As the decision in Bell v. Gray was rendered before any testimony was taken in the case, Edison must be held to have taken his testimony in accordance therewith.

The Commissioner there said: "The subject matter of 'Interference A' is the method, * * * while the subject matter of this 'Interference B' is a device which constitutes a part of the means for effecting the method." As the method includes the transmission as well as the reproduction of the sound waves, and "the source of undulatory electric energy" is by implication a part of the issue, and as the other parties to it all show and describe speech transmitters, it is evident that the interpretation of the office is the only one which would justify the presence of Edison as a party contestant.

The issue, then, is to be regarded as embracing a receiver consisting of an armature plate (which may be a diaphragm) and an electromagnet placed in closed circuit with an articulating transmitter.

To establish his case reliance is chiefly placed by Edison upon Exhibits A, A', B (upon which his interference application is based), 22-9, and Caveats 74 and 75. Exhibits A and A' have been considered in discussing Issue A, and what was then said regarding them applies equally now. They could not have been used in closed circuit with an articulating transmitter, because Edison, at the time of his unsuccessful experiments with them in December, 1875, had no knowledge of such an instrument, and after that they were laid aside. That they now can be used as receivers or transmitters is of no consequence. They were not so used until the way had been pointed out by Bell, and then only in the effort to deprive him of the fruits of the discovery he had given to the world. But for this they might never again have been seen or heard of.

Exhibit B is an instrument similar to that shown in Fig. 4 of Caveat 74, and is also shown in Case 145 without its induction coil. Its date is not certainly fixed, but Edison says he is positive it was made within a month, either way, of the 15th of November, 1875. This instrument consists of a resonant tube with a slotted diaphragm before which a tongue attached to one of the arms of a permanent magnet is vibrated by means of an electro-magnet connected to an induction coil, so that reversed currents are passed through it. As described in Caveat 74—and, in fact, this instrument relates purely to multiplex telegraphy, and is adjusted to a particular rate of vibration, corresponding to that of the transmitter, an arrangement which would entirely defeat the transmission of speech—Edison himself says it "could not have worked satisfactorily, and it did not do so;" but even if this receiver was capable of use with an articulating transmitter no such transmitter was within Edison's knowledge at that time.

Exhibit 22-9 also relates to acoustic telegraphy, and embraces two sheets of sketches. The one with which we have to do was made by Hatcher, is dated December 20, 1875, and is stated by him (A. 17) and by Edison (A. 20) to correspond in all re-

spects to Exhibits A A', except that a strip or band of metal was substituted for the diaphragm of the resonator.

Caveat 75 also relates to multiplex telegraphy, and the figures of its drawing, upon which reliance is placed, are 12, 15, 16, and 17. Instruments were made upon the plan of Figs. 12 and 17 in November or December, 1875, and of Fig. 16 in 1877. The first two only need be considered here.

Fig. 12 shows a receiver consisting of a resonant tube, over one end of which was stretched a membrane having attached to its center an armature formed of a cylindrical piece of soft iron, which entered a hole in a coil of insulated wire. This instrument is said by Edison to have been "used as a receiver for receiving audible sound waves transmitted through the medium of electric waves, which it did satisfactorily." The tube, however, is a Helmholtz resonator, which responds only to the rate of vibration of its included column of air, and is described so in the caveat.

Fig. 17 also shows a Helmholtz resonator, which in this instance is surrounded by a helix, but was a failure in operation. (A. 48.)

It is clear that Edison cannot prevail as to this issue.

ISSUE G.

"A telephonic receiver consisting of the combination in an electric circuit of a magnet, and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality."

Bell, patent No. 174,465, March 7, 1876.

McDonough, application April 10, 1876.

Richmond, application August 24, 1877.

Gray, application No. 3, October 29, 1877.

Dolbear, application October 31, 1877.

Edison, application No. 48, December 24, 1877.

Holcombe, application January 28, 1878.

The parties here are Bell, McDonough, Gray, and Edison.

This issue is in substantially the language of Gray's claim, and its exact scope and meaning have been made the subject of much controversy. The controversy has arisen from the fact that the issue states the combination as a telephone receiver, and its object,

the reproduction of both the pitch and quality of the transmitted sound.

On this account it is contended on the part of Bell that there must be read into the claim a device for transmitting quality, that is, an articulating transmitter, and on the part of Gray that it is sufficient if the transmitter transmits "syntactical vibrations of any and every description, including the tones of the human voice and articulate speech." McDougall, it seems, agrees with Bell.

The examiner, reasoning from the premise that while the other parties show articulating transmitters, neither McDougall nor Edison does, and Gray contemplates the transmission of sounds produced either by mechanism or the human voice, reaches the conclusion that the issue embraces any receiver consisting of the elements named, whether used in connection with an articulating or other transmitter, and whether it reproduces quality or not.

"The construction given the claim," he says, "the combination of the electro-magnet, the diaphragm, and an electric circuit over which sound-producing currents are transmitted, is in harmony not only with the express declaration of the applicant upon whose demand for a patent these proceedings were instituted, but also with the action of the office in including the applications of Edison (No. 148) and McDougall.

"If an articulating transmitter forms an essential element of Gray's claim these applications could not properly have been joined in the interference, for neither sounds or describes such an invention."

It is, however, necessary for the determination of the issue that some kind of transmitting instrument be used to throw sounds upon the line. The terms of the issue require this, and also that the quality of such sounds shall be reproduced. Hence if it be possible some means must be adopted to bring all the parties within these terms, but to do this the manifest requirements of the issue should not be disregarded.

It is held by the examiner, as above quoted, that a limitation of the issue to an articulating transmitter would do violence to the direct statement of the applicant whose claim forms the basis of this issue, but this does not necessarily follow. Upon examination of Gray's specification it appears that he states the object of his invention to be "to provide an apparatus capable of accurately reproducing in an electric circuit not

only the different tones but the pitch and quality of sounds, whether produced by mechanism or the vocal organs." In Fig. 2 he shows his receiver in connection with a series of vibrating reeds, each transmitting a tone of different pitch, which may be operated simultaneously or successively. It is not fastened to transmit quality with this apparatus, but the statement is simply that the *tones* are transmitted and reproduced. When, however, the arrangement shown in Fig. 3 is described, in which receiver and transmitter are alike, it is expressly stated that "articulate words spoken in one instrument will be accurately reproduced in the other, both as to pitch and quality as well as *tone*." It is upon this latter description that the claim is based, for after stating the elements of the combination he uses substantially the language employed in describing Fig. 3, "whereby sound thrown upon the line may be reproduced accurately as to tone, pitch, and quality.

It thus appears that not only is no violence done to Gray's statement by such a limitation of his claim, but that a fair inference to be drawn from considering it in connection with his specification is, that he himself so intended to limit it; else why insert so carefully the word "quality?" The fact that his receiver is also capable of reproducing other sounds should not be decisive in construing the issue. The greater includes the less. If a given apparatus transmit and reproduce quality, it will likewise pitch and tone, and the issue is not who first constructed a device to reproduce these, but these in conjunction with quality.

As to Edison, it is true that his application, No. 148, does not show or describe an articulating transmitter, and that he, therefore, does not transmit quality; neither does McDougall. It is, however, none the less true that Edison's application, No. 145, does not disclose such a transmitter, but the Commissioner, when these issues came before him for construction and reformation, held that Issue B, which includes and is, in fact, based upon Edison's claim in No. 145, embraces a device which was a necessary part of the means for carrying out the method involved in Issue A, *i. e.*, the transmission of articulate speech. Following his lead, this tribunal made an articulating transmitter an element of that issue, and such a course is equally proper here, for this issue was similarly construed by the Commissioner in that same decision.

In considering it he says:

"It is true that this receiving device is but the transmitting device of 'Interference G' reversed, but the fact that the device as used in 'Interference G' would enable an undulatory current of electricity to reproduce, at the point of delivery, the same sound vibrations which had been caused by *articulate speech* at the starting point, was not enough to suggest to the skilled workman or electrician that the same device would, if reversed, enable the sound vibrations, caused by the *spoken word*, to cause such variations of the electric current as to reproduce at a remote point of the circuit the same sound vibrations."

Language could not more plainly indicate than this the guiding principle of this entire proceeding, and it was not only the intent of the office that the invention of the speaking telephone should be tried here, but it was also the intent of the parties. Their testimony has all been directed to this end, and with the exception of Gray they are all still insisting that they invented not only the art but the apparatus. At the beginning of this controversy Gray made the same contention, and filed simultaneously three applications, one for the method, one for the transmitter, and one for the receiver. That he has withdrawn from the contest, except as to this issue, does not entitle him to have one of these applications used as a basis for an interpretation which neither he nor the other parties originally intended. Bearing this intent in mind, then, and the further fact that no other one of the issues will permit it, where else shall the question of priority as to the receiver be determined if not under this issue?

It was pertinently remarked by counsel for McDonough that without an articulating transmitter the receiver of this issue could not be practically tested, and its capability of reproducing indiscriminately the quality of any and all sounds could not therefore be known. It may as pertinently be asked, how then can the question of priority be decided upon an issue whose terms require the transmission of quality unless the only instrument which has this capacity be included, *i. e.*, an articulating transmitter?

To sum up briefly, it appears that this interference was sought by the parties to determine who invented the speaking telephone, the art and apparatus for carrying it out; and the decision was made by the primary examiner for the same purpose. The

Commissioner, upon a proceeding to reform the issues, reexamined and confirmed this, the parties accepted it, and the testimony was taken with it in view. Gray formerly insisted, and Edison and McDonough still insist, that not only the art is of their invention, but the apparatus also, and it is only by including an articulating transmitter in this issue that the question of priority as to the receiver can properly be determined.

If the construction of the issue given by the examiner of interferences is to prevail, and priority be awarded to a party who had no articulating transmitter, it would result that an experimenter who had tried to transmit speech and failed, or one who had never tried, should so dominate the art that an inventor who had worked out the idea, patented his process of carrying it out, introduced it to the public and put it into extensive use, could not practice the art which he had created without being tributary to his unsuccessful rival.

The view of the issue to be adopted being now settled, the uses of the respective parties may be considered.

Bell stands upon his patent as before. Edison relies upon his Exhibits A and A'. These have already been considered under Issue A. They were used in experiments in acoustic telegraphy, were Helmholtz resonators, and never did transmit quality before the date of Bell's patent, because they were never used with an instrument capable of such transmission. The fact that they can now be used for this purpose is of no consequence. Edison, in the fall of 1875, when they were experimented with, could not have known that they would transmit quality, and he only found this out after Bell had pointed out the way to him. Granting, however, that they really possessed this capacity, these instruments were thrown aside as defective for the very purpose for which they were constructed.

Three of them were made in November, 1875, and used in connection with reeds of different rates of vibration, and their object was to reinforce the tone of these at the receiving end of the line, each receiver being adapted to its corresponding reed. (A. 18.)

The testimony of Johnson is clearest as to the use of these devices. He assisted Edison in his experiments with them, and as he was a Morse operator received the sounds transmitted and translated them, the object of the experiments being, as he states, "to transmit a constant tone, or rather a series of them, and by

interrupting each tone with a Morse key to throw it into dots and dashes of the telegraph."

"Various forms of these receivers were used in the effort to find one which would only respond to a given tone. The present form, which constitutes these exhibits (A and A') I remember were objectionable, because they reproduced not only all the tones of the transmitting reeds, but also the false or foreign sounds due to an interference with the transmitting instruments." (A. 2.)

To obviate this defect and get a receiver which would respond only to a given tone, other instruments were made having instead of a complete diaphragm like A and A', merely a strip, "hearing," as Edison says (A. 145), "some relation in its vibrating time to that of the particular series of waves which it was desired to render audible."

Professor Spiller also testifies as to the imperfection of exhibits A and A'. "The sounds," he says, "were musical, and agree mainly with the reeds or forks, but not always, on account of the instrumental appliances not being brought to perfection." (A. 20.)

Now, when it is remembered that in acoustic telegraphy the object to be accomplished is to have the receiver accurately respond to one particular tone, and one only, the defect of these receivers is plainly apparent, and it can be readily understood why they do not appear in any of the experiments after November or December, 1875. Edison, it is true, says they were used from the time they were made in November, 1875, at various intervals up to the spring of 1877, and Batchelor, "during a period extending from November, 1875, to the spring of 1876 (A. 18)" but no mention is made of any specific purpose for which they were used, except "to render audible acoustic vibrations" (Batchelor), and "for receiving acoustic vibrations transmitted electrically" (Edison), and both these expressions are put into their mouths by the questions of Edison's counsel. As further indicating that these receivers were not considered of practical importance may be mentioned the fact pointed out by the examiner, that although caveat 75, which covers improvements in acoustic telegraphy, contains several acoustic receivers, these exhibits were not even referred to.

Edison, therefore, cannot be held to have antedated Bell. Gray, as before stated, has withdrawn from the contest as to all but this issue. His case does not rest upon the fact that he

is the inventor of the art or even of an articulating transmitter, but upon the proposition, as stated by his counsel, that "having invented, discovered, and reduced to practice prior to the other contestants in this case an apparatus involving the combination" of the issue, he "is entitled to a patent for that apparatus with all its functions, incidents, and capabilities, whether known at the time or not."

Stated more specifically, his proposition is—

"That, as certain devices he mentions are not only capable of acting as receivers of articulated speech, but when properly organized as to their circuit, connections will operate both as receivers and transmitters of articulated speech, * * * it makes no difference whether Gray knew or not that his instruments possessed this quality, so long as they did possess it. Gray knew that his receivers would reproduce the quality of sounds transmitted through the line, and he believed that if he could transmit articulated speech it would probably be reproduced, but he at that time did not have the conception of such a transmitter."

This is, indeed, a shadowy theory upon which to rest his case, and the most conclusive answer to it is that of counsel for McDonough, before quoted, that he could not know his receiver would reproduce speech unless he was able to test it, and this could only be done by a speech transmitter. If he did not know this how could he impart the knowledge to the public, and how obtain a patent?

It is a proposition to the grant of a patent that it shall convey to the public the knowledge necessary to enable it to practice the invention, and it is just here that Bell and Gray differ. If Gray had obtained a patent for his instruments which he now says can transmit and reproduce speech, the public would not have been in any manner enlightened as to this art. He stands in an entirely different light from Bell, and the decision of Mr. Justice Lowell in *American Bell Telephone Company v. Spencer, infra*, does not help him. It was not held in that case that it was enough for a person to have constructed an apparatus capable of doing a certain thing although he did not know it. Another and a controlling element entered into the decision, that a mode of doing this thing had been pointed out and that the apparatus operated after this mode.

"There is some evidence," says the court, "that Bell's experiments with the instrument described in Fig. 7 before he took

out his patent, were not entirely successful, but this is now immaterial, for it is proved that the instrument will do the work, whether the inventor knew it or not, *and in the mode pointed out by the specifications.*"

Gray had not only not pointed out how his receiver could reproduce speech, but he did not know himself until taught by Bell's patent.

In this view of the case it will not be necessary to look into Gray's evidence, for it is admitted that he had never transmitted speech before the date of Bell's patent or application, and in the view we take of this issue it is immaterial when the devices upon which he now relies were constructed.

The case of McDonough is somewhat similar to Gray's, though with this important difference, that he still insists that he is the inventor of the speaking telephone. His case, as stated by his counsel, is as follows:

"We submit, therefore, that Mr. McDonough was the original and first inventor, because he had in 1867 practically used the magnet and diaphragm in combination for a receiver; had in 1871 conceived of the use of said combination for articulate speech; had reduced the same to a drawing, and in April, 1874, attempted to embody the same; being prevented by sickness, he went to Europe; returning in the fall of 1874, he began in April, 1875, again to put his receiving apparatus together, and combined and used it with a transmitter in May, 1875, and applied for his patent April 10, 1876."

All these acts of McDonough may be admitted, and yet priority cannot be awarded to him unless he can be shown to have had an articulating transmitter. Upon this depends his entire case, and it becomes important to determine what he really had. And first as to the apparatus shown in his application.

This consists of a stretched membrane upon which are secured two metal plates insulated from each other. Between these plates and insulated from them and also attached to the membrane is a metal post upon which is arranged an arch-shaped piece of metal capable of upward and downward movement upon the post. The ends of this arch piece rest upon the plates attached to the diaphragm.

The receiver is composed of a membrane stretched upon a suitable frame and having an armature attached to it, in front of which is an electro-magnet.

The entire apparatus is placed within an electric circuit, and when the membrane of the transmitter is caused to vibrate by a sound uttered in front of it, it alternately connects and disconnects the ends of the arch-shaped piece from the plate on the membrane, thus making and breaking the circuit, and consequently alternately magnetizing and demagnetizing the electro-magnet of the receiver and vibrating the receiving membrane.

This apparatus is termed by McDonough a teleogue, *i. e.*, a far-speaker, and it is stated to be capable of transmitting and reproducing speech, but it is evident that it can of necessity have no such function. It is now well known in the art that in order to transmit speech there must be constant contact, but here a device is expressly provided which breaks contact at every vibration of the diaphragm. It is just such an arrangement which prevented Reis's telephone from transmitting speech, and it is equally fatal to McDonough's.

The similarity of the two apparatus was at once apparent to the office, and McDonough's application was rejected upon the Reis instrument. In this view McDonough acquiesced, for he took no action in the case for nearly two years and then caused all his claims and inserted a limited claim to the specific construction of his transmitter. At the same time, however, by an ingeniously worded amendment he attempted to introduce the features of a metal diaphragm and constant contact, but to this the office very properly objected.

It thus appearing that the apparatus described in McDonough's specification, which was presumably the best known to him at that time for accomplishing the results he asserts, was incapable of transmitting speech, it is clear that like Gray he could not have had a receiver which he knew could reproduce it, and could have conveyed no information to the public.

This is conclusive against his right to an award of priority, but as it is still strenuously urged that he is the inventor of the art and apparatus, it may be well to consider the evidence upon which he relies.

Some time in 1867 he made an instrument "for the purpose of converting an interrupted current of electricity into continuous sound." This instrument consisted of an electro-magnet before the poles of which was placed a paper diaphragm stretched over an iron hoop and supported in an upright position by several

looks. Upon the center of the diaphragm there was pasted a piece of tinned iron. This apparatus was placed in circuit with a battery, and a circuit breaker introduced in the shape of a file.

When a loose end of one of the connecting wires was drawn over the file the circuit was alternately made and broken, with the usual result of magnetizing and demagnetizing the electro-magnet, vibrating the diaphragm, and producing a continuous sound. This apparatus was not shown or described to any one, and there is nothing now left of it except the iron ring and a part of the battery. Apparently he did not attach much importance to it, as he says he took no particular care to preserve the parts. Several persons are mentioned who, McDonough says, knew he was experimenting with electrical instruments, one of whom is dead, but none of those living is called except Wilsey, and all he can tell is that McDonough told him he "thought he could send sound over a telegraph wire." (A. 6.)

A sketch dated August 26, 1871, is produced, and is stated to be a memorandum of several methods of making an instrument for transmitting speech when opportunity should offer. This sketch is labeled "to send speech through wires by means of electricity," and is of such a character that no information of a positive character can be derived from it. It apparently represents a receiver like that above referred to in circuit with a transmitter, which is said to consist "of a membrane stretched over a hoop, in the center of which membrane or diaphragm is fastened a small piece of metal connected by wire with the magnet of the receiver. Upon this small piece of metal rested a piece of metal in the shape of a pin, which was supported by a frame. This metal pin was connected by wire with the battery, thus completing the circuit."

Other sketches also appear which he says were different plans of constructing a transmitter (A. 15), but there is no means of judging how any of the so-called transmitters were to operate. Probably, as he afterwards made a transmitter on the principle of Reis's, those were intended to be of the same character, a supposition which is strengthened by his statement that he was familiar with the state of acoustic science at that time, including the Reis instrument. (A. 14.)

Nothing more was done by McDonough until April, 1874,

at which time he says his attention was again called to the transmission of articulate sounds telegraphically, and he began work upon an instrument for that purpose, but his efforts were limited to putting his "batteries into shape," and having made a magnet of rod iron at the center or base of which was soldered a screw for the purpose of fastening the magnet to the frame. (A. 21.)

It does not appear what then revealed the matter to his attention, but Eastman says that some time in the spring of 1874, he and McDonough were looking through a book in which the latter had drawings of different instruments, and McDonough said he thought it was possible to send speech over a wire, and showed him "a drawing of a machine that he had previously made for that purpose." (A. 3.)

About the middle of May, 1874, McDonough went abroad on account of his health, returning in November of the same year, and nothing more appears to have been thought of the telephone until the latter part of April, 1875.

A plea of ill health and the exigencies of business has been set up to excuse McDonough's lack of diligence in the prosecution of his invention between 1871 and 1875, but there is nothing in the evidence, except his own statements as to what he did in 1874, from which we can suppose that even if he had had abundant leisure anything further would have been done by him if he had not read in the Chicago Tribune of April 22, 1875, an account of the exhibition of Gray's musical telephone.

Directly after reading this article McDonough was walking home with Eastman, and the conversation was upon this subject. McDonough explained Gray's instrument to Eastman and said: "I know that I can make a machine that will send speech over a wire." To which Eastman replied, "If you know you can do it, why don't you?" After reaching home, McDonough showed his sketch of August, 1871, to Eastman, and together they went to the garret and picked out from a box some fragments of old apparatus which McDonough said he would fix up and try and make a machine, or what is now called a "telephone." (McDonough, A. 24; Eastman, A. 10.)

In pursuance of this determination in the latter part of May following he began operations. The apparatus which he then constructed consisted of two tin cases covered with a parchment

diaphragm. Upon the one which was intended for use as a receiver he pasted a piece of tinned iron, and in front of this he placed an electro-magnet, as before.

The transmitter was similar to the receiver. Upon a small piece of German silver attached to its diaphragm rested a needle which passed through a glass tube and had the capacity of moving upwardly and downwardly in the tube. This transmitter operated upon the make-and-break system, and, as could only be expected, when tested in the latter part of May, 1875, transmitted tunes, but no words. (McDonough, A. 24.)

Subsequently, and about June 1st following, a slight change was made in the transmitter, by which a thin strip of German silver was substituted for the tin foil connection between the needle and the screw-eye to which the wire was attached. Upon testing this the result was, according to Eastman, "a variation of rattling sounds and musical tones, and at times we could distinguish the tune that was sung."

About the middle of June following another apparatus was constructed, and as it was substantially like that embodied in his application it need not be specifically described. It also operated upon the make-and-break plan, and is the apparatus which is urged as McDonough's final and successful reduction to practice of the speaking telephone.

McDonough's statement is—

"That the results obtained by it were clearly recognizable tunes, and entire sentences of clearly understood words were transmitted through the instrument and heard at the receiver. To my own knowledge the tunes were 'Swanee River,' 'Mullin Min,' 'Slow Fly,' and some others. The words which impressed themselves upon me particularly were 'Way down upon the Swanee River, far, far away,' which I heard consecutively and clearly, noticing the elision at the beginning of the word 'way,' and the change of 'v' to 'b' in the word 'river.' The words of other tunes were distinct when the instruments were properly regulated. I myself could distinguish peculiarities of voice in these speaking or singing. I don't remember what spoken words, if any, were used at this time." (A. 38.)

Eastman, who assisted at these experiments, also gives the names of several tunes which he heard, and says:

"I heard many of the words of these songs; exactly which words I can't remember. I also heard McDonough say 'Hallo, Frank,' and other words I can't remember now." (A. 21.)

Wiley says:

"I could hear singing. I was able to determine what tune he was singing. I was also enabled to catch now and then a word, that is all?" (A. 19.)

John E. McDonough says:

"I heard the singing. I heard 'Down come uncle and aunt; down come sister Caturah' (words of a song with which he was familiar). That's about all that I can recollect, at the time, of hearing."

These are the only witnesses who testify as to having heard any sound transmitted by McDonough's instruments, and it is to be noted that they are all of McDonough's family: Eastman, his brother-in-law; Wiley, his step-father; John E. McDonough, his brother.

It is also to be noted that not one of them, except Eastman, is able to testify to hearing any spoken word ("Hallo, Frank!"), and that all the other words testified to were those of the familiar songs the tunes of which were transmitted. No doubt the words were as familiar as the tunes, and under such circumstances it was easy for the imagination to supply them. If the instrument had been able to transmit words, many would, doubtless, have been transmitted, and the witnesses would remember that fact as readily as they now remember the transmission of the tunes.

Upon the whole, McDonough's proofs cannot be held to be sufficient to overcome Bell's record dates. We have seen that a party contesting the right of a patentee must show completed and perfected apparatus. That McDonough did not have this is clear. Had a patent been granted to him for it as described in his application or as experimented with in June, 1875, the public would have been no wiser than before. It still would have been ignorant of the method and apparatus for speech transmission, for no instrument working upon its principle of making and breaking contact can accomplish that result. In this respect McDonough gave no more to the world than Reis. As was said of Reis, by Mr. Justice Lowell, in *American Bell Telephone Company v. Spencer*, above, a century of McDonough would never have produced a speaking telephone.

Inter. J.

"The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for rendering audible acoustic vibrations."

Bell, patent No. 186787, January 30, 1877. Applications filed January 15, 1877.

Edison, application No. 148, December 24, 1877.

Gray, application No. 3, October 29, 1877.

Dolbear, application October 31, 1877.

Richmond, application August 24, 1877.

Holcombe, application January 29, 1878.

The only parties here are Bell and Edison.

This issue is in the language of Edison's first claim, and question has also arisen as to its scope owing to the fact that Edison's application, as has been before seen, relates only to acoustic telegraphy, and the resonant case which is made an element of the claim is a Helmholtz resonator. The use of such a resonator, as has already been pointed out, is fatal to the reproduction of speech, as its inclosed air column re-enters only a particular tone and suppresses the others. As the inventions of the other parties all embrace speaking telephones, resonators having the analyzing function of Edison's are not shown in their several cases. Bell only, whose patent refers to multiplex acoustic telegraphy also, states that when a number of messages are receiving at the same time "it will be advisable for the operator to listen to his telephone through a resonator, which will re-entrance to his ear the signals which he desires to observe." Had Bell and Edison been the only parties originally in interference this statement of Bell's might perhaps have removed the difficulty, and made the interference relate to the use of an analyzing tube in connection with a magnet and diaphragm, but as the other parties were included who neither show nor describe such combination, such a construction of the issue will be of no avail here. This will be apparent from a consideration of the matter disclosed by each party.

Bell describes his diaphragm as a plate of iron or steel fastened to a sounding box. This box is nothing more than a hollow case within which the magnet and diaphragm are inclosed. Its only effect would be to amplify the sound in the manner of a violin body. (Bell, vol. III, X-A, 16.)

Dolbear does not show any case at all or a resonant tube like Edison's. His diaphragm is attached to a solid support or frame with an opening in the center. Fig. 4 of his drawing shows, and his specification describes, a tube placed in front of

the diaphragm, but its only action would be that of the mouth or ear piece of a speaking tube.

Gray shows a trumpet-mouth or basin-shaped vessel, the bottom of which constitutes his diaphragm.

Holcombe and Richmond, originally parties, also show simple mouth and ear pieces.

It will thus be seen that none of the parties except Bell either show or describe such a resonant case as Edison's specification and claim describe.

The matter is still further complicated by the statement of the examiner in declaring the interference that the issue is embraced in Bell's and Dolbear's respective third claims. Neither one of these claims, however, contains any reference to a resonant case.

Bell's claim is:

"The combination with an electro-magnet of a plate of iron or steel capable of inductive action, which can be thrown into vibration by the movement of surrounding air, or by the attraction of a magnet."

Dolbear's:

"One or more helices or coils included in the circuit of the main line and surrounding core or cores, in combination with an elastic induction plate or armature facing the poles of said core or cores, and a rigid support or frame to which the opposite edges of said plate or armature are secured."

The problem presented by this state of facts is how to construe the issue so that Bell's patent, the applications of the other parties, and the three claims of Bell, Edison, and Dolbear may be held to cover the same subject-matter, for it is evident that if Edison's application and claim show to be the guide, there would be no interference. It is true the dissolution of the interference might be recommended, but remembering the present advanced stage of the case, the failure of any of the parties, to whom all of these matters have long been known, to seek dissolution in the manner prescribed, and above all the controlling fact that this proceeding was instituted, and by common consent has been extended to have been instituted, to try the question of the inventorship of the speaking telephone, it is thought best to pursue the course adopted by the examiner of interferences, and award priority upon a meaning given to the issue which will best accomplish this end. If either party feels aggrieved by this course, his remedy is ample.

The effect of the adoption of a contrary course is so clearly set out by the examiner that we quote his language entire:

"It results from this condition of affairs, that the inventor of a device consisting of an electro-magnet and a diaphragm fastened to the end of a resonator, and used in connection with a reed or harmonic transmitter with whose rate of vibration the column of air is in accord, the whole being so arranged, adjusted, and used that the tones produced by the vibrations of the transmitter shall alone be rendered audible—that the inventor of such a device, adapted and used only as an acoustic or harmonic telegraph receiving instrument, may claim and thereby subordinate an instrument which, although it includes the diaphragm and electro-magnet, is so constructed and used that instead of responding to one tone only, as produced by a vibrating reed with which its resonator is made to accord, responds to any and all tones not produced but transmitted by an instrument acting under the influence of sound waves.

"Yet such would be the legitimate outcome of this interference were it proved that Edison's invention of the device shown and described in his application antedated the inventions of the other parties."

To denote this difficultly two constructions of the issue are presented—one by the decision of the examiner of interferences, and the other by the argument for Bell. Both of them may be here stated. The former is, in effect—

An instrument for rendering audible acoustic vibrations, consisting of an electro-magnet and an iron or steel diaphragm, secured at its edges to a resonant case, consisting either of a resonator which picks out and responds to a given series of electrical waves, or a conveyor which confines and directs all sound waves; the latter—

A speaking telephone receiver, consisting of an electro-magnet and an iron or steel diaphragm mounted on a suitable support. Though this latter construction appears to be more in accordance with the spirit of this interference, and the recognized purpose for which it was declared, it in fact makes little difference which is adopted. In either case the establishment of Edison's contentions would give him an award of priority.

The question of priority may now be considered. As to this, Bell, as before, stands upon his patent No. 186,787, granted January 30, 1877, upon an application filed January 15, 1877, and if these dates be not overcome they are sufficient to estab-

lish his right to the matter at issue. As it can be done in a few words, it may, however, be as well to state what it is upon which Bell relies to establish his case without regard to the application for, or grant of, his patent.

It does not appear when the matter of this issue, as construed by Bell, was first conceived by him, nor can he tell when he first described it or caused drawing or model to be made. He thinks this was done about the end of March or the early part of April, 1876, not long after the grant of his patent of March 7. Neither is it altogether clear when he first embodied it in an instrument, but he thinks Exhibit 40 is the original (Dowd, vol. I, X-A, 200), and Watson testifies that this was made by him sometime before May 10, 1876. (Watson, X, 36, 67.)

The exhibit consists of an upright cylindrical iron box, within which is an electro-magnet whose pole is near the top of the box. A thin metal plate or foil constituting the diaphragm is placed upon such top, with its edge upon the rim of the box, and its center a short distance above the pole of the magnet. It was used by Watson in May, 1876, as a transmitter; was exhibited at a meeting of the American Academy of Arts and Sciences at the time of the delivery of Bell's lecture on May 10, 1876, and at the Centennial Exhibition on June 25, 1876, was operated as a receiver. (Vol. III, X-A, 6, 36; Watson, A, 36; Huddard, Dowd, vol. I, A, 5, 6, 7.)

Upon the construction adopted by the examiner of interferences the date of invention is somewhat later. The first receiver, having a sounding box like that of Bell's second patent, was made in October, 1876, operated on a line between Boston and Cambridge about the same time, and with some alterations, *etc.*, covering up the hole in the top of the box and adding a mouth-piece and air space in front of the diaphragm, was filed as a model with the application of January 15, 1877. (Bell, vol. III, X-A, 3, 4; Watson, Dowd, I, A, 38-40, 68.) The exact date of making this instrument cannot be ascertained, but it was at least before January 15, 1877. This date is, however, not material, as it is undoubtedly true, as stated by the examiner of interferences, that "Bell had practically made the invention when he suggested and applied the first iron diaphragm. He had invented and applied all the other elements, and the iron diaphragm was to take the place of the membrane diaphragm previously employed."

Edison's case must rest as before upon his Exhibits A and A'. The character of these instruments has already been sufficiently explained, and as has been seen in discussing Issue G, they can be considered only as experimental devices which worked imperfectly and were abandoned. Long after they were thrown aside Edison in his experiments used membrane diaphragms, and the only instances of the use of metal in undoubted speech-transmission experiment was after the date of Bell's patent.

It thus appears that in either view which may be taken of the meanings of this issue Edison has neither overcome Bell's novel dates nor gone beyond his ascertained date of invention.

ISSUE L.

"First. The combination in an acoustic telegraph of an electro-magnet and a polarized armature formed of a *plate of iron, steel, or other material capable of inductive action, and a resonant tube or case.*

"Second. The combination in an acoustic telegraph of an armature plate polarized by induction, a resonant case or tube, and an electro-magnet and circuit connections, whereby reversed currents are caused to act in the electro-magnet with varying intensity proportionate to the electric waves sent from the transmitting station."

Bell, patent No. 174465, March 7, 1876.

Edison, application No. 145, December 13, 1877.

Gray, application No. 4, January 17, 1878.

The only parties here are Bell and Edison.

The counts of this issue are in the language of the first and second claims respectively of Edison's case 145, and embrace substantially the same subject-matter, only the circuit connections and a statement of the function of the combination being appended to the second.

A difficulty similar to that in Issue A arises also here, for Edison's application relates only to acoustic multiplex telegraphy, and his resonant case, as in each issue, is a resonator.

The so-called resonant cases of both Bell and Gray are only mouth or ear pieces, and in order to reconcile the differences between these several devices and sustain the declaration of interference the examiner found it necessary to consider them as equivalents and to disregard the distinction between acoustic telegraphs and speaking telephones. With his view of the is-

ssue or that urged by counsel for Bell, that, as in Issue J, the resonant tube or case is simply a frame for supporting the diaphragm, the question of priority upon the first count of the issue as declared may be determined; otherwise the interference should be dissolved.

As the second count includes circuit connections and reverse currents, the examiner was also obliged to give a forced construction to it. Neither Bell nor Gray uses connections like Edison's, as will be apparent upon considering their respective disclosures.

Edison's apparatus, as described in his application 145, consists of an electro-magnet between the poles of which there is an armature. This armature is polarized by attachment to one of the poles of a permanent magnet and forms one end of a resonant tube. The line passes through a helix around whose core is an induction coil in the local circuit of the magnet. When a rise and fall of tension is produced in the line circuit the current induced in the local circuit will be alternately positive and negative, the polarization of the cores of the magnet will be reversed, and thus the armature, which is in fact a reed, will be vibrated and reproduce the sound given to the transmitter. The resonant tube re-enforces the sound.

Bell's apparatus is the familiar one of Fig. 7 of his patent. An armature is pivoted at one end to one of the poles of an electro-magnet and its other end is fastened to the center of a membrane diaphragm stretched over one end of a cone. At the transmitting end the membrane is over the smaller, and at the receiving the larger end of the cone. Here is an electro-magnet, a polarized armature, and a sound conveying and conveying tube, but no resonator. There are also currents of opposite polarity caused by the vibration of the polarized armature of the transmitter in front of the pole of the electro-magnet, but no such reversed currents as Edison produces.

Gray's apparatus need not be particularly described, as he is not a party here. Its consideration is only valuable in the construction of the issue, and it is enough to say that for the purposes of this issue his apparatus is the same as Bell's.

Upon this state of facts this branch of the interference might also properly have been dissolved. Indeed both parties now involved agree that it was improperly declared, but considering,

as before, that no motion to dissolve has been made, and that the speaking telephone is acknowledged to be the thing in controversy in this entire proceeding, it can do no harm to adopt the view of the examiner of interferences and determine this issue upon that basis.

"To support the declaration of this event," says the examiner, "it is necessary not only to reconcile the differences between the systems and the resonant cases, but to hold that, having referred to one mode of producing reverse currents of varying intensity, Edison is entitled to claim, as an element of the combination, any and all mechanism for so doing, irrespective of differences in purpose, mode of operation, and effect.

"Upon this hypothesis we may presume that because Bell and Gray employ magnet-to-transmitters, producing reverse currents, in combination with the other elements named in Edison's claim, they disclose the combination, including the circuit connections mentioned in the declaration."

Adopting then this view of the examiner, the cases of the parties may now be considered.

Bell relies upon his instruments constructed in June and July of 1875. The first of these is shown in Exhibit 31. This exhibit is a reproduction, but it is substantially like the original. It consists of a wooden tube and ring upon which is stretched a membrane. An electro-magnet attached to a cross bar projects in front of this membrane, and to a pole of the magnet is pivoted an armature or reed, the other end of which is attached to the center of the membrane. This instrument was not used as a receiver but as a transmitter, in connection with a harmonic receiver. Bell states that it was his intention to have a duplicate receiver made, but his anxiety to experiment with his new instrument did not permit him to wait for that. On July 2 he directed Watson to make another membrane instrument. A duplicate of this is in evidence as Exhibit 34, and the original was constructed and experimented with as a receiver some time in same month. (Dowd, A, 74-90.) Bell's account is substantially corroborated by Watson (*Id.*, A, 17-23), so that as Bell was diligent in obtaining a patent embodying this apparatus, his date of invention may be fixed as early as July, 1875.

Edison's operations, on the other hand, did not begin until June or July, 1875, directly after President Orton spoke to him of Gray's invention in acoustic telegraphy. His Exhibit B,

upon which he relies, and which has already been described in considering Issue E, was not made until October or November of 1875, proved a failure in use, and with the exception of its illustration and description in Claim 74, relating purely to acoustic telegraphy, was not heard of until it made its appearance in application 145, also relating to acoustic telegraphy, and filed nearly two years after the grant of Bell's patent, and after his telephone had gone into public use and become widely known.

The examiner of interferences correctly awarded priority to Bell upon this issue.

ISSUE No. 1.

"A spring forming or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and the diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm."

Edison, application No. 141, July 20, 1877.

Blake, application May 10, 1879.

Irwin, application May 24, 1879.

Voeelker, application September 26, 1879.

The parties here are Edison, Voelker, and Irwin.

This issue embraces a variable resistance transmitter, and is in the words of the claim in Blake's application. Blake contemplates two arrangements. While in both one electrode is mounted upon a spring, in one the other electrode is directly attached to the diaphragm, and in the other is held in contact with the diaphragm, but is mounted upon an independent support. Both these means of mounting this electrode were considered by the office, and undoubtedly are, equivalents, and therefore the other parties who show the first were put into interference with Blake.

It is insisted by counsel for Voelker and Irwin that Edison does not show, or his specification describe, the invention involved in this issue. It therefore becomes necessary to consider the instrument described in his specification.

It consists of a tube, over one end of which is placed a diaphragm. On each side of this diaphragm is a contact spring, having a point of compressed pliancy. These points are directly opposite each other, and make contact of discs of platinum attached to the opposite sides of the diaphragm. As an alternative construction there is described a U-shaped spring carry-

ing between its forks a piece of rubber to prevent sonorous vibrations. A contact point of plunlago is attached to one prong of this spring. It is urged that as this form is the one preferred by Edison, and the other is stated to be merely illustrative, it must therefore be "taken as the invention intended to be protected by the patent." From this stand-point it is argued that the U-shaped spring and interposed rubber do not constitute a spring, and that therefore the subject-matter of the issue is not disclosed. This is, however, disposed of by the statement of the specification, that the object of this device is "to present a semi-right point for contact, so as to prevent a rebound," (or, as is elsewhere stated, "to prevent the prongs acting as a tuning-fork," "and allow of a slight yield when the plunlago is pressed by the diaphragm." This slight yield is sufficient to constitute a spring action, within the meaning of the issue, and Edison's application must be held to be rightly included in it.

The devices of Voelcker and Irwin need not be particularly described, further than that Voelcker shows one electrode mounted upon an upright spring, the other being either the diaphragm itself, if of metal, or a metallic disc attached to it, if of membrane; and Irwin, a spring-controlled needle, preferably of platinum, set at right angles to the plane of the diaphragm, constituting one electrode, the other being either the diaphragm itself or a piece of carbon attached to it.

The finding of the examiner of interference is that the subject-matter of this issue "was not in fact or in law made by Voelcker, while neither Blake nor Irwin claims to have begun operations on the telephone until subsequent to Edison's record date."

Blake not being a party here no inquiry need be made as to him, and it will be sufficient for the purposes of this case to determine whether or not this finding of the examiner is correct.

As to Irwin, it is truly stated by the examiner that the earliest date set up in his preliminary statement is October, 1877, and as this is over two months subsequent to the date of filing of Edison's application, judgment might long since have been rendered against him on the record.

Turning now to his testimony, it appears that it accords with his preliminary statement, for he expressly says that he "first began experimenting on electric telephones October, 1877" (A. 3), when Voelcker brought some apparatus to his house at

Morton. This completely disposes of Irwin's case, and it need not further be gone into. The examiner has discussed it at length, but only it seems, to round out his decision.

Voelcker's operations began in the fall of 1875, but his first experiments were not until the latter part of February or first of March, 1876. To establish his case under this issue he relies upon his Exhibits A and H, the first made in April, 1876; the last in October, 1877.

The material parts of Exhibit A consisted of a cylinder of wood having a membrane over one end, to which was attached a piece of iron. Facing this iron contact piece was a flat steel spring carrying a platinum point, the tension of the spring being regulated by a screw. Connection was made with the battery by means of a wire attached to the flat spring and another attached to the contact piece on the membrane. In his experiments with this the results were no different from those with his former instrument; he got only "a few musical tones now and then."

It is thought from the fact that Voelcker speaks of screwing up the spring "until the point touched the contact piece," and "adjusting the point with different pressures," that he had a variable contact, but there is no evidence in the case that he ever had any such idea. On the contrary, in the instrument, he first constructed, in which one of his electrodes consisted of a nail, the point of which rested upon the contact piece on the membrane, he called his apparatus a Morse or telegraphic key (A. 5), and his theory, as stated by him, was derived from what he knew of the Morse key in telegraphy. "It" says he, "it was possible to construct a key delicate enough to be manipulated by the sound waves, then the transmission of sound would be realized." (A. 5.)

Here, as before, we have the make-and-break system, upon which, it is now a well-established fact, articulate speech cannot be transmitted. Voelcker had only reinvented the Reiss telephone, and nothing new. Nor does anything more favorable appear in his subsequent experiments. Without taking them all up in detail, it is enough to say that musical sounds were transmitted, but no speech.

These experiments were carried on with more or less diligence until December, 1876, when they were interrupted until April,

1877. At that time, having read of some telephone concerts in New York, he again began experimenting, but with no better results than before. This continued until January, 1878, and always with the same result. There was no successful transmission of articulate speech. Exhibit II was not made until October, 1877, which is too late as against Edison.

It is now strenuously denied that Voelker's instruments were mere circuit breakers, and upon this point it may be well to refer to the fact that after carefully examining Voelker's instruments, Irwin, who is now Voelker's employer and lawyer, pronounced this opinion upon them: "After examining the transmitter and receiver," he says, "I remarked to Mr. Voelker that his transmitter was a Reiss transmitter, or a reproduction of the Reiss transmitter."

Eminent solicitors were also consulted by Irwin upon this point, and both of them concurred in his opinion. The following is his account of this:

"During Christmas week of 1877 I was in Chicago, and laid the matter of Mr. Voelker's telephonic experiments before Mr. J. M. Thatcher. * * * Mr. Thatcher's opinion was that the instruments described and illustrated by me by drawing were reproductions of the Reiss transmitters and receivers. * * * Mr. R. D. O. Smith, of Washington, one of my solicitors, April or May, 1878, * * * came out to Marion. * * * I spoke to him about Voelker's telephonic inventions. * * * describing by illustration Mr. Voelker's claims. * * * Mr. Smith concluded that Voelker's inventions were but a reproduction of the Reiss and others." (Irwin, A. 2-7.)

The importance of this testimony as making against Voelker cannot be overlooked, and its force is not lessened by the fact that Irwin had and still has an incorrect notion of the operation of Reiss's instrument. (A. 10.)

That Reiss did not have a variable contact instrument, or one that could transmit speech, is well established. It is possible that he may now and then have transmitted a word, but we have no knowledge on the subject. So, also, may Voelker, but it was accidental. A momentary adhesion of the contact pieces might have resulted in the transmission of an occasional word, but he did not know how it was done, and could not at will make his instruments so operate.

It must be concluded that Voelker also has not overcome Edi-

son's record date. It is therefore unnecessary to look into Edison's testimony.

Priority was correctly awarded to Edison.

The decision of the examiner of interferences is affirmed as to all the issues except (1), and as to that his decision is reversed and priority of invention awarded to Bell.

ROBERT J. FISHER, JR.,
R. L. B. CLARKE,
H. H. BATES,

October 23, 1884.

Examiners-In-Chief.

In The United States Patent Office.

ON APPEAL: BEFORE HON. COMMISSIONER OF PATENTS IN PERSON.

TELEPHONE INTERFERENCES.

CASE G.

PARTIES: BELL, McDONOUGH, GRAY AND EDISON.

Brief for Thomas A. Edison.

This interference relates to:

Bell's Patent 174,464, March 7, 1876.

McDonough application filed April 10, 1876.

Gray " " October 29, 1877.

Edison application No. 148 filed Dec. 24, 1877.

Subject matter as officially stated.

" A telephonic receiver consisting of the combination in an electric circuit of a magnet, and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality."

The examiner of interferences held that this interference embraces "a receiver containing an electro magnet and a diaphragm supported and arranged in close proximity thereto, and adapted to respond to variations in the electric current passing through coils in the magnet when used in connection or combination with a transmitter adapted to create sound-producing

fluctuations in the electric current, whether said electric variations, waves, pulsations, or modulations, represent or are derived from sound waves or mechanical vibrations."

Upon this construction of the issue he awarded priority of invention to McDonough.

To this finding Bell, Gray and Edison appealed.

The Board of Examiners-in-Chief held that the issue should be construed as requiring that a particular kind of transmitter should be used, viz, one that would transmit quality as well as pitch and tone—and upon this construction of the issue the Board awarded priority to Bell.

To the finding of the Examiners-in-Chief Edison, Gray and McDonough have appealed.

In almost all these interferences, difficulties have arisen from the indefinite wording of the issues and from interpretations being put upon these issues that were not warranted by the specifications in which the claims of the issues were first made.

Mr. Edison has made no claim in his application (139) in this interference, nor has he contended in the testimony, that he was the first person to transmit articulate speech from one end of an electric circuit and receive it at the other.

Upon the construction adopted by the Examiners-in-Chief he must therefore claim priority to Bell.

In his application (148) in this interference, Edison has described, as used at one end of his electric circuit as an acoustic transmitter, a pair of instruments, in each of which a spring harmonic reed is employed as an essential feature. At the other end of the line he describes a pair of receivers, one for each transmitting instrument, each receiver in fact having substantially the construction of the speaking telephone receiver of to-day.

The words of his claim are:

"The combination with an electro-magnet of an iron or steel diaphragm secured to a resonant case for re-

dering audible acoustic vibrations, substantially as specified."

The testimony clearly shows that the identical receivers A and A', embodying the invention referred to in the claim, and introduced by Edison as exhibits, were made and practically used in November, 1875. The testimony also shows that Edison continued to use receivers of the same construction, as receivers of musical sounds during the years 1875 and 1876. (See exhibits, Prescott's Exhibit, Vol. II., p. 545, and Batchelor's testimony, Vol. I., p. 355.)

Batchelor testifies to musical exhibitions in the early part or summer of 1876, before even Bell had used an iron diaphragm with an electro-magnet for receiving at one end of an electric circuit *any kind* of sounds that had been transmitted from the other end of the circuit. The instruments are still in existence and are in working order.

Further, the testimony shows that up to the time that Edison filed this application (Dec. 24, 1877) he continued to use similar receivers both in speaking and in musical telephones.

Indeed, in his application (130) filed April 27, 1877, this same receiver is shown in connection with an instrument adapted to transmitting speech. In application 130 he says:

"At the receiving instrument there is an electro-magnet O with its poles facing the diaphragm d, and the armature 2 is fastened to said diaphragm, or the diaphragm itself may form the armature if made of soft iron."

The application 130 should have been included in this interference.

See also Edison's Carent No. 75, filed in January, 1876, showing the receiver now claimed. *This caveat was filed before Bell's application*, and before Edison could have learned of Bell's peculiar use of the apparatus.

Edison has complied with the law by explaining the principle of his receiver, and "the best made in which he has contemplated applying that principle."

As against Bell, then, this interference should be dissolved and the claim allowed to Edison in the works in which he makes it.

But if the issue is to be construed as being for a receiver containing an electro magnet, and a diaphragm supported and arranged in close proximity thereto, regardless of the kind of transmitter to be used therewith, the interference should continue and the claim must be allowed to Edison as the first inventor, as against Bell and McDonough.

Clearly nothing could be more erroneous than to say that Edison ever for an instant abandoned, either in speaking telephones or in musical or harmonic telephones, the invention which proved so successful in his harmonic apparatus of 1875.

It is immaterial to him on the question of abandonment that Bell, either as an original inventor or as copying him, made use of the same receiver in a speaking telephone.

Clearly Edison has never lost the right to use his receiver in harmonic telegraphy, just as it is shown and described in his application (148) in this interference.

Clearly Edison was the first to successfully construct and use the receiver referred to in his claim of the said application which is in this interference. He merely contends that that claim should be allowed him. It should be a question for the Courts to decide, whether such a claim allowed to him would cover the use of the same instrument in combination with a different transmitter from the one used by him.

As against Gray, he contends that Gray did not have in his wash-basin any diaphragm in the sense of the diaphragm of the present day. Gray certainly did not have the electro magnet, diaphragm and supporting case of Edison's claim.

LEMUEL W. SERRELL,
Attorney for T. A. Edison.

Telephone Interferences [Volume 6]

Cases 2 and 3

The table of contents, all preliminary statements and interfering specifications, and the evidence for Edison have been filmed. Edison exhibits that were filmed in Volume 2 have not been refilmed.

Samuel M. Snell

Argument notes

IN THE MATTER OF TELEPHONE INTERFERENCES.

ON PETITION BEFORE THE COMMISSIONER OF PATENTS.

EDISON

BLAKE.

CHINNOCK.

Cases 2 and 3.

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5. EVIDENCE OF EDISON.
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BOSTON

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REBUTTING EVIDENCE ON BEHALF OF BLAKE.

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EDISON'S EXHIBITS.

Letters Patent No. 203,014, April 30, 1878 After page 62
 Edison's Exhibits Nos. 42-11; 106-11; 112-11; 2-12; 6-12; 163-12;
 168-12; 17-12 " " "
 "Cover for Exhibits—Laboratory Notes—T. A. Edison" " "
 "Journal of the Telegraph," April 16, 1878 " "
 Single page exhibit, showing Edison's "Springs 112-11" " "
 "Steel diaphragm;" "Spring, March, 1877" " "
 "Cup and carbon 112-11"; "diaphragm 112-11" " "
 "Diaphragm 165-12"; "weights 112-11" " "
 Chinnock's Exhibit "A" (put in by Edison) " "
 Edison's Exhibits 9-11, 111-11, [as between Edison and Blake] " "
 Stipulation for admission of Exhibits 59-11 and 111-11, as between
 Edison and Blake " "

BLAKE'S EXHIBITS.

Exhibits Nos. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11 After page 129
 Exhibit No. 8, printed with testimony Page 79

CHINNOCK'S EXHIBITS.

Exhibits 1, 2, 3, 4, 5, 6, 7, 9 and 10 After page 209
 Exhibit 8, not printed with Chinnock's Exhibits, but shown with
 Edison's patent, No. 203,014, immediately after page 63

United States Patent Office.

THOS. A. EDISON

v.

FRANCIS BLAKE, JR.,

v.

CHAS. E. CHINNOCK.

TELEPHONE INTERFERENCES,
CASES 2 AND 3.

RECORD.

DATE OF DECLARATION OF INTERFERENCE IN BOTH CASES, AUG. 14, 1879.

CASE 2.

SUBJECT MATTER.

The subject matter involved in the interference is the yielding weight connected with the movable electrode to resist the movement of the diaphragm and modify by its inertia the variation of pressure between the two electrodes (Blake's fourth claim, substantially claimed by Edison [claim 3] and by Chinnock [claim 1] and shown by Phelps).

CASE 2.

INTERFERING PARTIES.

Thos. A. Edison, of Menlo Park, N. J. App'n filed Nov. 11, 1878 (Case 158). Att'y of record, L. W. Sorrell, Box 4,689, N. Y. City.

Charles E. Chinnock, of Brooklyn, N. Y. Application filed Dec. 26, 1878. Att'y of record, Edwin H. Brown, 7 Warren Street, N. Y. City.

Francis Blake, Jr., of Weston, Mass. Original application filed Jan. 3, 1879. Application divided, and split-off-application filed May 10, 1879, the claims being renumbered. The renumbered

claims of Blake's original application are those referred to in the declarations of interference in cases 2 and 3. Att'y of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

Geo. M. Phelps, of Brooklyn, N. Y., application filed June 4, 1879, was originally included in this interference, but priority was decided against him by official letter of Oct. 24, 1879 on his concession in favor of Edison.

CASE 3.

SUBJECT MATTER.

The subject matter involved in the interference is the springs in combination with the piece of graphite, or similar material, between them and the diaphragm of a telephone instrument (Edison's second claim, described by Chinnock and covered by Blake's third claim).

The combination is in a telephone of an electric circuit, a vibrating diaphragm and a flexible weighted circuit governor (Chinnock's second claim. Described and shown by Edison and by Blake).

CASE 3.

INTERFERING PARTIES.

Charles E. Chinnock, of Brooklyn, N. Y. App'n filed Dec. 26, 1878. Att'y of record, Edwin H. Brown, No. 7 Warren Street, N. Y. City.

Francis Blake, Jr., of Weston, Mass. Application filed Jan. 3, 1879. Att'y of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

Thos. A. Edison, of Menlo Park, N. J. Application filed June 2, 1879 (Case 178). Att'y of record, L. W. Serrell, Box 4, 689, New York City.

CASE 2.

PRELIMINARY STATEMENT OF FRANCIS BLAKE, JR.

Prior to the fourth day of July, 1878, I made no inventions of my own, but had experimented for a few weeks trying to reproduce the inventions of others.

I made use of the device referred to in this interference during the

month of July, 1878. The first instrument in which I made use of it is still in my possession.

I have several instruments containing this device which were made between July and November, 1878. At the last-mentioned date the Bell Telephone Company began to manufacture the Blake transmitters, and have used the said device in several thousand instruments.

FRANCIS BLAKE, JR.

CASE 2.

PRELIMINARY STATEMENT OF CHARLES E. CHINNOCK.

Charles E. Chinnock, being duly sworn, deposes and says that he conceived of the invention in controversy, as near as he can now determine, between the first and tenth days of November, in the year 1877; that he then made a drawing thereof; that he thereafter devoted as much attention to said invention as he could do; and made other drawings illustrative thereof; that he experimented with said invention in the month of December, 1877; that he commenced the construction of an operative telephonic transmitter embodying said invention about the time last named, and completed and used such telephonic transmitter in the early part of the month of April, 1878; and that he subsequently made other telephonic transmitters embodying the said invention.

C. E. CHINNOCK.

CASE 2.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that on March 25, 1877, he made and tested an apparatus which contained substantially the point in controversy, and the same is shown in his patent, No. 203,014, filed July 20, 1877. That he made an apparatus which more closely resembles his application, No. 158, Fig. 1, filed Nov. 11, 1878, and has drawings of the same made and dated July 5, 1877.

A device operating similarly is shown in his British patent, No. 2,909, of 30th July, 1877. That deponent has drawings of various modifications of transmitting telephones worked by inertia, made in July, September and November, 1877, and up to the filing of his application, No. 158.

THOS. A. EDISON.

CASE 3.

PRELIMINARY STATEMENT OF FRANCIS BLAKE, JR.

Prior to the 4th of July, 1878, I made no inventions of my own, but had experimented for a few weeks trying to reproduce inventions of others.

I made use of the devices referred to in this interference during the month of July, 1878. The first instrument in which I made use of them is still in my possession. I have several instruments containing these devices which were made between July and November, 1878. At the last-mentioned date the Bell Telephone Company began to manufacture the Blake transmitter, and have used the said devices in several thousand instruments.

The modification, however, by which the springs carrying the electrodes were made to press against each other as and for the purpose set forth in my specification, was not made till December, 1878.

This modification does not seem to be in interference.

FRANCIS BLAKE, JR.

CASE 3.

PRELIMINARY STATEMENT OF CHARLES E. CHINNOCK.

Charles E. Chincock, being duly sworn, deposes and says that he conceived of the invention in controversy, as near as he can now determine, between the first and tenth days of November, 1877; that he then made a drawing thereof; that he thereafter devoted as much attention to said invention as he could do, and made other drawings illustrative thereof; that he commenced the construction of an operative telephonic transmitter embodying the said invention about the time last named, and completed and used such telephonic transmitter in the early part of the month of April, 1878, and that he subsequently made other telephonic transmitters embodying the said invention.

C. E. CHINNOCK.

CASE 3.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that the combination of two springs having between them a piece of graphite

and pressed to the diaphragm of a telephone was reduced to practice May 31, 1877.

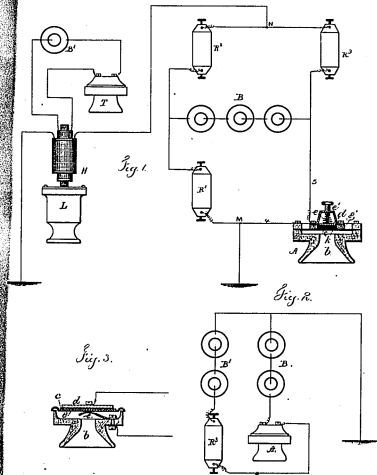
That he cannot recall how long previous to then it was received; that he has a drawing of the instrument, and shall probably be able to produce the model or some of the parts thereof; that in October, 1877, deponent made a number of instruments with double springs having carbon between them, which pressed upon the telephone diaphragm; that he has many drawings showing different forms, in September, October and November, 1877.

The flexible weighted circuit governor, in connection with an electric circuit and a telephone diaphragm having metallic points, as in the application of Chincock, was devised and tested by him some time in 1877, in connection with musical telephones, the same being inoperative for speaking telegraphs. The exact date of construction and reduction to practice deponent cannot now give, as he has mislaid some diagrams which he hopes to find, and is unable to recollect the date, in consequence of the great number of devices of this general character that have been made and used by him.

THOS. A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says, in addition to the foregoing, that as early as March 25, 1877, a weighted spring circuit governor, with a diaphragm, was practically constructed and tested and operated successfully; that he is unable to say when he first conceived the feature in question, but believes that he spoke of the same to other parties between January, 1877, and the time of constructing the device, in March, 1877.

THOMAS A. EDISON.



Witness

Geo. W. Smith
Geo. D. Buckley

Inventor
Thos. A. Edison
per Samuel H. Gould, atty.

SPECIFICATIONS OF THE APPLICATIONS EMBRACED IN INTERFERENCES 2 AND 3.

THOMAS A. EDISON, OF MENLO PARK, N. J.,

Att'r to Western Union Telegraph Company, of New York.

PENDING APPLICATION FILED NOV. 11, 1878. (No. 158.)

IMPROVEMENT IN TELEPHONES.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, have invented an Improvement in Telephones, of which the following is a specification:—

The object of this invention is to transmit oral communications over electric circuits, and said invention consists in devices for transmitting positive and negative currents by varying the resistance in the telephonic transmitter in combination with a Wheatstone balance.

The transmitting instrument containing carbon or similar material in the circuit is also peculiarly constructed [and the receiving instrument is provided with a peculiar tympanum.]

In the drawing

Fig. 1 represents the transmitting instrument sectionally, and also shows the circuit connections by a diagram.

Fig. 2 represents the circuit connections in a slightly modified form, and

Fig. 3 shows [the receiving] *a variation in the transmitting** instrument sectionally.

The transmitting instrument A contains the mouthpiece b, and a diaphragm k, secured at its edges. The centre of the diaphragm is platinized and upon this rests a button c, of finely divided conducting material such as metallized charcoal, lampblack, or iodide of copper. The metallic plate d is kept in contact with the button by the rod and spring e, and e' is an adjusting screw to regulate the pressure of the plate d upon the button c. Said screw passes through the metallic support that is secured to the vulcanite ring g around the button c.

Parts in brackets struck out by amendment.

* These words in italics inserted by amendment.

The diaphragm is connected to the wire 4, and the plate *d* to the wire 5.

[Any atmospheric vibrations acting on the diaphragm, *k*, produce a variation in the resistance of the carbon, or similar button, *c*, in the electric circuit, in consequence of the difference in pressure upon such carbon button resulting from the momentum of the parts and the inertia of the plate *d*.]

The ring g is upon the diaphragm k, and hence moves with it, but any atmospheric vibrations acting on the diaphragm k, produce a variation in the resistance of the carbon or similar button, c, in the electric circuit, in consequence of the difference in pressure upon such carbon button resulting from the momentum of the parts and the inertia of the plate d.

The transmitter, A, is in one branch of the Wheatstone bridge, R¹, being a resistance equal to that of A, when not subjected to sonorous vibrations; R² and R³ form the other sides of the balance, and have equal resistances. The bridge wire from M to N is contained in the telegraphic circuit that extends from M to N in the wire to the distant receiver, H, thence to the earth and returning to the earth plate at the receiving station and to it. The battery, B, of several cells, is between 5 and R¹, R².

When the resistance of A, R¹ is equal to that of R², R³, no current circulates upon the line. When sonorous vibrations vary the resistance of the carbon button, *c*, in A, the current will pass upon the line in one direction or the other. When the resistance of A is increased, the current passes in one direction; when it is lessened, the current passes in the other direction, in consequence of the balance being disturbed.

The induction coil, H, has its secondary coil included in the line circuit, and the primary coil is connected with a transmitting instrument T, constructed and operating in a similar manner to the transmitter A, the local battery, B¹, being in the circuit through the carbon button and primary coil. The receiving instrument, L, is provided with a diaphragm that is acted upon by the core of the induction

Part in brackets struck out by amendment.
Part in italics inserted by amendment.

coil, H, and hence the induction coil is utilized and serves for receiving or transmitting telephonically.

In Fig 2, the balance of the similar batteries, B, B¹, with opposite poles to line, is obtained by the rheostat R², that is of a resistance equal to that of the instrument A when at rest, and when the resistance of the carbon button in A is increased or decreased by the sonorous vibrations, the current will pass upon the line either positive or negative according to the resistance in A.

In Fig 3, a modification of the transmitter is shown. The plate, 6, rests against a disk of fibrous substance *c*, such as silk with a finely divided material such as plumbago, worked into its fibres; there may be several such disks, and the plate *d* is at the opposite side of these disks *c*, and is sustained in place by a cross bar or yoke connecting at its ends to the outer surface of the back edges of the washpieces, or in any other suitable manner. [There are edges that] The edges of the plate 6, are turned over to receive the edges of the washpieces *b*, and a spring *e*, presses the plate 6, towards the disks of silk so as to hold them against *d*. One conductor from an induction coil passes to *d*, and the other to 6, and the slightest sonorous waves acting against 6 vibrate the same and the resistance in the electric circuit is varied according to the pressure upon the disk of prepared fibrous material.

This last named transmitting device is simple and cheap, but not very loud.

In my application No. 130, the diaphragm is in direct contact with a surface of plumbago or similar material, and in my application No. 151, patented April 30, 1878, No. 203,016, a carbon button and a diaphragm are employed, and there is a metallic plate intervening and in direct contact with both the carbon and the diaphragm; it is therefore to be understood that these features do not form the subject of the present invention.

I claim as my invention

First. The combination with an induction coil of a diaphragm that is acted upon by such induction coil, and gives out sonorous vibrations, substantially as set forth.

Part in brackets struck out by amendment.
Part in italics inserted by amendment.

Additional
Claims
needed

X
EDISON'S SPECIFICATION (CASE NO. 128).

Second. In combination with the balanced circuits a telephonic instrument included in one circuit and acting to vary the electric condition of the line by the resistance that is controlled by the sound vibrations, substantially as set forth.

Third. A transmitting telephone containing a variable resistance in the electric circuit and a body acting by inertia to vary the resistance in proportion to the sound vibrations, substantially as set forth.

Signed by me this eighth of November, A. D. 1878.

Witnesses:

S. L. GRIFFIN.
CHAS. BATCHOLDER.

Ex'd. E. A. M., II. M. H.

THOMAS A. EDISON.

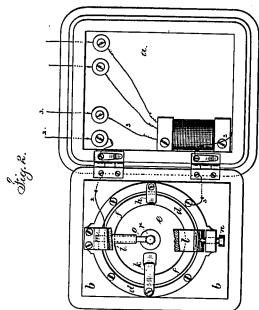


Fig. 2.

Case 178.

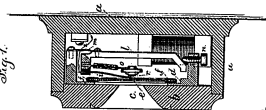


Fig. 1.

Witnesses
Charles Smith
Wm. J. Packard

Inventor

Thomas A. Edison
for Samuel H. Sewell

THOMAS A. EDISON, OF MENLO PARK, N. J.

Att'or to Western Union Telegraph Company, of New York, N. Y.

PENDING APPLICATION FILED JUNE 2, 1879. (Sta 178.)

TELEPHONES.

To all whom it may concern:—

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, have invented an Improvement in Telephones, Case No. 178, of which the following is a specification:—

This invention relates to what is known as the carbon telephone, in which the sonorous waves are translated into electric waves by means of the variable pressure exerted upon finely divided material, such as lampblack, carbon, graphite, or other material acting in a similar manner, and placed in the electric circuit.

In my patent, No. 203,014, I have shown a diaphragm, and adjustable springs with pieces of carbon or plumbago, adjacent to the diaphragm, and also a piece of rubber across the diaphragm. In my patent No. 203,016, there is set forth a compressed carbon button between two platinum disks that are in the electric circuit, and the vibrations of the diaphragm vary the pressure upon the carbon button in proportion to the amplitude of the vibration. In my patent No. 203,013, there is an elastic cushion in connection with the diaphragm and the circuit conductor.

In my application No. 161, there is a diaphragm, and a carbon button supported by a yielding lever, and in my application No. 158, filed Nov. 11, 1878, there is a diaphragm and a body acting by inertia upon the circuit-regulating button, that is between the diaphragm and said body.

More or less of the features heretofore referred to enter into this present application, but it is to be distinctly understood that I do not herein lay any claim to either of the devices shown in such former applications.

My present invention relates to a diaphragm surrounded with a band of india rubber or similar yielding material, to allow of the vibration of such diaphragm by the action of the sonorous waves, but to check or arrest any prolonged or false vibrations, *in combination with* [and it further relates to] an elastic dampening finger resting

Part in brackets near foot of page struck out by amendment.

Part in italics near foot of page inserted by amendment.

upon the diaphragm, and also to two adjustable springs or spring arms, between which is placed a piece or button of carbon, graphite, or similar material acting by the pressure from the diaphragm to vary the resistance in the circuit.

In the drawing, Fig. 1 is a vertical section of the telephone, and Fig. 2 is a rear view of the diaphragm, with the lever bar partially removed.

The box *a* is of any suitable character, and the front *b* is provided with a mouthpiece or opening at *c*.

d is a metal ring or frame, and *e* is the diaphragm. *f* is a ring of india rubber or similar yielding material, that interposes between the edge of the diaphragm and the frame *d*, to allow of the vibration of the diaphragm, and to check any false vibrations of the same. *h* is the clamp to hold the diaphragm near one edge, and *k* is a spring finger, armed at the end with india rubber, or similar yielding material, pressing upon the diaphragm near the middle to hold it in place, and also to act as a damper to lessen false vibrations.

The spring arms *i* and *o* are insulated from each other, but connected with the circuit wires 2 and 3, and between them is the button of graphite or equivalent material at *r*.

The spring *l* is in contact with the diaphragm, and it will receive motion from the sonorous vibrations that act upon the diaphragm, and vary the pressure upon the graphite and produce rise and fall of the electric tension.

The metallic disk at the back of the piece of carbon acts by inertia, as a resistance; the spring arm *o* is also stiffer than the spring *l*.

The lever bar *l* is connected with the frame *d* by means of the spring *m*, and said lever bar forms the support for the ends of the spring *i* and *o*, so that by moving this lever bar the pressure of *i* on the diaphragm can be regulated. The screw *n* holds the lever bar *l* in position when adjusted.

One circuit wire 3 may be connected to the frame *d*, the other to the insulated spring *i*. The springs *i*, *o* are in a local circuit in which is contained a battery and the primary helix of an induction coil, which in turn translates the electric waves of the primary into the secondary coil which is included in the line circuit.

The word "also" in italics inserted by amendment.

I claim as my invention,

First. In combination with the diaphragm of a telephone, a band of yielding material around the same, at or near the edge, and a dampening finger for the purposes set forth.

Second. The springs *i* and *o*, in combination with the piece of graphite or similar material between them, and the diaphragm of a telephone instrument, substantially as set forth.

Signed by me, this thirtieth day of May, 1879.

THOMAS A. EDISON.

Witnesses:

STOCKTON L. GRIFFIN,
WM. CARMAN.

Fig. 1.

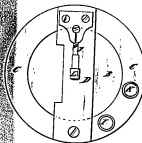


Fig. 2.

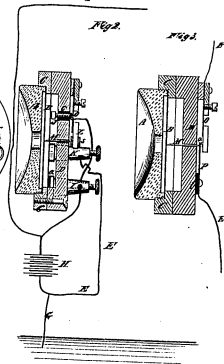
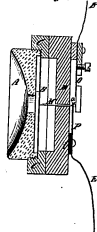


Fig. 3.



Witness:
 Wm. B. Wright,
 Wm. B. Wright.

Inventor:
 Charles E. Johnson
 by his attorney
 Edwin H. Brown.

CHARLES E. CHINNOCK, OF BROOKLYN, N. Y.

PENDING APPLICATION FILED DEC. 26, 1876.

TELEPHONES.

To all whom it may concern:

Be it known that I, Charles E. Chinnock, of Brooklyn, in the County of Kings and State of New York, have invented certain new and useful Improvements in Telephones, of which the following is a specification:—

The object of my improvements is to provide a telephone whereby sound waves may be reproduced with greater volume and transmitted [greater] longer distances than heretofore.

[One improvement consists in a telephone comprising the combination of an electric circuit, a vibratory diaphragm actuated by the impact of sound waves and a circuit governor controlling the passage of electricity through the circuit and actuated by the movements of the diaphragm so that the circuit is wholly or partially opened and closed proportionally to the force of the impact of sound waves on the diaphragm and hence.]

My invention consists in the combination in a telephone of an electric circuit, a vibrating diaphragm actuated by the impact of sound waves, and a circuit governor acted upon by the diaphragm so as to control the passage of electricity through the circuit, and weighted in such manner that it will, when acted upon by the diaphragm, acquire a momentum, and move or swing aside a distance proportionate to the strength of the sound waves actuating the diaphragm, and hence will keep the circuit broken accordingly, thereby effecting the transmission of electricity so as to reproduce the sounds with distinctness and volume, at the receiver of the telephone. The sounds may be transmitted for almost any distance and with great volume.

Another improvement consists in the combination in a telephone of an electric circuit, a vibratory diaphragm and a flexible circuit governor, preferably pendulous and weighted, whereby the motions

Parts in brackets struck out by amendment, Feb. 25, 1879.

Parts in italics inserted by amendment, Feb. 25, 1879.

of the diaphragm are made to swing the circuit governor aside, and thus control the passage of electricity through the circuit.

Another improvement consists in the combination in a telephone of a divided electric circuit, a diaphragm capable of movement by the impact of sound waves, a pendulous circuit closer weighted near the free end, acting in conjunction with one division of the electric circuit, and capable of being swung aside by the movements of the diaphragm above said, to break the said division of the electric circuit more or less, and correspondingly control the passage of the current of electricity through the other division of the electric circuit, whereby I provide in a very desirable way for causing the sounds actuating the diaphragm to be reproduced in great volume and transmitted great distances.

It also consists in details of construction to be hereafter explained.

In the accompanying drawing, Fig. 1 represents a back view of the telephone transmitter embodying my improvements. Fig. 2 is a central vertical section of the same, including representations of a divided electric circuit used in conjunction therewith, and Fig. 3 is a central vertical section of a modified form of transmitter. Similar letters of reference designate corresponding parts in both figures.

Referring to Figs. 1 and 2, A designates a mouthpiece which may be of the ordinary funnel shape contracted inwardly, and B designates a diaphragm of flexible material, such, for instance, as sheet metal, supported in a frame C, preferably made of metal, behind the mouthpiece. D designates a bridge-piece extending across the back of the frame C. E, G designate a divided electric circuit. One division, E, of this electric circuit extends, in the present example of my invention, from an electric battery H, thence in one direction through a binding screw I, insulated by a suitable washer piece D, and thence to a screw J, arranged in the bridge-piece, and insulated by a bushing, K, from the bridge-piece; and the screw K, arranged upon the frame C, and thence through the said frame C, to a circuit governor, whereby the said division of the circuit is partially or wholly broken or closed. The other division of the circuit consists of a line wire F, leading to the receiver, and a ground wire G. The circuit governor O, which I have repre-

sented, consists of a flexible metallic strip mounted on a block in electrical communication with the frame C, and extending into proximity with the screw J, aforesaid, so that it may be in contact therewith. Preferably it will be provided with a weight such as that L, and is arranged like a pendulum, as shown. M designates a pin extending from the diaphragm B, projecting through the bridge-piece D, and adapted upon the circuit governor near the free end so as to transmit motion thereto. The portion of the circuit governor upon which the pin, M, acts is shown as provided with a band of India rubber *x*; and this is advantageous for transmitting the vibrations of the diaphragm to the pendulum, and as a damper for the circuit governor, preventing it from rebounding.

Movements of the diaphragm caused by the impact of sound waves against it are imparted by the pin M to the circuit governor, swinging it more or less backwards, and thereby partially or wholly severing its contact with the screw J. Weak sound waves will merely act on the circuit governor sufficiently to make its contact with the screw J less perfect and extensive, and permit of the passage of a correspondingly greater current of electricity through the division F G of the circuit. Strong sound waves swing the circuit governor backwards sufficiently to entirely remove it from contact with the screw J, and permit of the passage of the entire current of electricity through the division F G of the circuit. Thus the sound waves are made to control the transmission of electricity from the battery through the circuit proportionately to their strength, and the sounds are reproduced in the receiver in volume increased by reason of the force of the electric current. The advantages of providing the circuit governor with a weight is, that it will, when actuated by the diaphragm, acquire a momentum whereby it will be retarded in returning, and hence will leave the division of the current which it controls partially or wholly open longer than otherwise, effecting distinctness and increasing the effect of the diaphragm on the electric current.

Although shown in connection with a divided electric circuit, my improvements are applicable to a single undivided circuit with advantage.

Although I may employ receivers of different kinds, I preferably use one comprising an electro-magnet in electric communication with the division *P G* of the electric circuit, a diaphragm capable of movement through attraction from the magnet, and an ear-piece. Such a receiver is advantageous because the slowness with which the magnetization and demagnetization of the magnet are effected conduces to a distinct enunciation of the transmitted sounds emitted by the diaphragm when moved by the magnet.

Referring to Fig. 3, *A* designates a mouthpiece, *B* a diaphragm, *M* a pin extending therefrom, *C* a frame, and *D* a bridge-piece like those above described. *O* designates a circuit governor in electric communication with the bridge-piece *D*, like that first hereinabove described. *P* designates a spring which may consist of a strip of spring steel, and which is shown as attached to the frame *C*, though insulated therefrom by a block of india rubber *t*, or its equivalent.

One pole of the division *E* of the electric circuit is attached to this spring *P*, and the free end of said spring extends between the pin *M* and the circuit governor *O*, and when actuated by the impact of the pin *M* against it swings (through a platinum point *o*, with which it is furnished) the circuit governor aside, more or less, establishing also electric communication with it, and controlling the passage of electricity through the division *P G* of the circuit. This modification of my improvements may be used if desirable.

It is obvious that instead of connecting one pole of the division *E* of the electric circuit with the screw *J*, it may be connected with the circuit governor *O*, and then the said division of the electric circuit may be connected and broken by the action of the pin *M* in conjunction with the said circuit governor, the band of india rubber being removed, so as to admit of electrical contact, and the circuit governor being insulated from the bridge-piece *D*.

What I claim as my invention, and desire to secure by Letters Patent is, —

First. A telephone comprising the combination of an electric circuit, a vibratory diaphragm actuated by the impact of sound waves and a *weighted* * circuit governor controlling the passage of electricity through the circuit, actuated by the movements of the diaphragm, substantially as and for the purpose specified.

* The word "*weighted*," inserted by amendment, Feb. 25, 1870.

Second. The combination in a telephone of an electric circuit, a vibratory diaphragm and a flexible, *weighted* * circuit governor, substantially as and for the purpose specified.

Third. The combination in a telephone of an electric circuit, a vibratory diaphragm and a pendulous *weighted* * circuit governor, substantially as and for the purpose specified.

Fourth. The combination in a telephone of a divided electric circuit *E, F, G*, a mouthpiece *A*, diaphragm *B*, pin *M*, frame *C*, bridge-piece *D*, screw *J*, circuit governor *O*, with its weight *L*, and insulator *S*, substantially as and for the purpose specified.

CHARLES E. CHINNOCK.

Witnesses :

EDWIN H. BROWN.

THOMAS E. BIRCH.

Words in italics marked thus * inserted by amendment, Feb. 25, 1870.

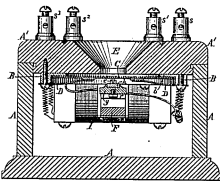


Fig. 3.

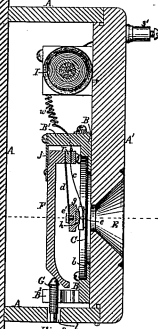


Fig. 2.

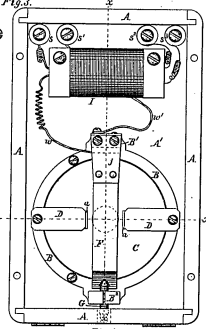


Fig. 1.

Inventor:

Francis Blake, Jr.

Witnesses:

William M. Davis
C. J. Olinde

FRANCIS BLAKE, JR., OF WESTON, MASS.

PENDING APPLICATION FILED JAN. 3, 1879.
IMPROVEMENT IN TELEPHONES.

To all whom it may concern:

Be it known that I, Francis Blake, Jr., of Weston, in the State of Massachusetts, have invented certain new and useful improvements in Speaking Telephones, of which the following is a specification:—

[One of my said improvements has reference to a method of holding the diaphragm of a telephone so that it will be free to expand or contract without altering its form. My other said improvements relate to that form of transmitting telephone in which the undulations or variations in the strength of an electric current necessary for reproducing sounds in a receiving instrument are produced by varying the resistance of the circuit through changes of pressure between two electrodes of the circuit. As heretofore constructed, one of the electrodes in such instruments* is held in fixed position, while the other, being free to move to some extent, is constantly held in contact with such fixed electrodes, and is* pressed against it with greater or less force by the vibrations of the diaphragm with which it is connected.]

My said improvements relate to that form of transmitting telephone in which the undulations or variations in the strength of an electric current necessary for reproducing sounds in a receiving instrument are produced by varying the resistance of the circuit through changes of pressure between two electrodes of the circuit. As heretofore constructed, one of the electrodes in such instruments is held in fixed position while the other, being free to move to some extent, is constantly held in contact with such fixed electrode and is pressed against it with greater or less force by the vibrations of the diaphragm with which it is connected. In using an instrument of this form it has been found necessary to adjust the initial static pressure between its electrodes with great care and delicacy in order to secure such a

* These words in italics inserted by amendment filed Feb. 7, 1879.

Paragraph in brackets struck out by amendment of May 4, 1879.

Paragraph in italics inserted by amendment of May 8, 1879.

variation of resistance between them under the vibrations of the diaphragm as will enable the current to reproduce in a receiving instrument the sounds which fall upon the transmitting instrument. When such an adjustment has been secured, it is easily disturbed by slight causes, such as a change in the temperature of the instrument, or a trifling movement of some of its parts in relation to other parts.

By my inventions the proper adjustment is easily secured, and is not liable to be disturbed in the practical use of the instruments. I support both electrodes in such a manner that they can move freely with the diaphragm. One of them may be attached directly to and be supported by the diaphragm, but I prefer to support it in contact with the diaphragm but by an independent support.

The other electrode is supported so as to move freely, but is made so heavy, or is so weighted, that by its inertia it will offer a resistance to the slight and quick vibrations of the diaphragm, which will change in the resistance of the circuit. This second electrode is so be sensibly affected by a change of temperature within the ordinary range of temperatures to which such instruments are exposed. It is on the end of a spring, the other end of which is connected to a lever by means of which the proper initial pressure between the electrodes and against the diaphragm is obtained.

To secure contact between the electrodes independently of the pressure against the diaphragm, I support the one next to the diaphragm upon a spring which exerts its pressure against the opposite electrode.

The manner in which I construct instruments, embracing my invention, is shown in the drawings hereto annexed, in which A represents a box or casing in which the mechanism of a telephone embracing my improvements is enclosed. This mechanism is for convenience attached to the cover or top of the box (A').

Fig. 1 is a plan of the mechanism attached to the top or cover of the box. Fig. 2 is a section of the box and mechanism taken through the middle on the dotted line $z\ z$ of Fig. 1, and showing one of the screw-cups for making connections with the exterior cir-

cuits. Fig. 3 is a cross section of the box and mechanism on the dotted line $z\ z$ of Figs. 1 and 2, and showing the screw-cups for making connections with the exterior circuits.

B represents a metal ring or frame for holding the mechanism of the telephone. It is screwed to the cover A' as shown, and has two ears B' B'. On the inner surface of the ring B is a narrow ledge or lip b on which the disk or diaphragm G is placed. This diaphragm is formed as usual of a thin iron plate. A lining of paper or other suitable material is placed between it and the ledge or lip, and it is held in place by two springs D D, attached to the metal rim or ring B, with their free ends pressing upon the back of the diaphragm near its centre so as to hold it against the ledge. Thin pads of rubber a a are placed between the ends of the springs and the diaphragm. By this method of holding the diaphragm in place, it is less liable to be distorted by a change of temperature than when held wholly at its circumference.

The centre of the ring and diaphragm is placed opposite the orifice E in the cover A' through which the sounds enter the instrument. On the other side of the diaphragm and at its centre is placed one of the electrodes. It is a small metal bar (e), one end of which rests against the diaphragm, the other end is brought nearly to a point and is in contact with the other electrode (e'). It is desirable that it should be formed of or plated with some metal like platinum or nickel, which is not easily corroded. It may be attached directly to the diaphragm, but I prefer to support it independently, as shown, upon a light spring e, which tends to press it away from the diaphragm and towards the opposite electrode.

This method of supporting the electrode insures its contact with the other electrode under some circumstances, when otherwise they would be liable to be separated and the circuit broken.

The other electrode e' is formed on a weighted spring d, which is supported on an adjusting lever F, by which the tension of the spring is regulated. This spring must be stronger than the spring e which supports the electrode e, and from its greater strength, it tends to keep the electrode e in contact with the diaphragm. It may be made of a piece of a common watch-spring, and it carries at its free end a weight g, heavy enough to check very greatly the

rate of vibration of the spring. This weight may be of metal, which may serve directly as the electrode, but I have obtained better results by applying to it, at the point of contact with the other electrode, a piece of gas coke or a hard pressed block of carbon *h*, such as is used for electric lights.

The employment of the coke or carbon does not, however, constitute a part of my invention further than it contributes a portion of the weight carried by the spring. If the weight is a non-conductor, as it may be, there must be a metallic conductor between the carbon or other electrode used and the spring or some other part of the circuit. The weight must be proportioned to the stiffness of the spring, a stiff spring requiring a heavier weight than a weaker one. The adjusting lever *F*, to an arm of which one end of the spring *d* is attached, is a stiff bar, connected at one end by a stiff spring *j* to the ear *l* of the ring *h*. The other end rests upon an adjusting screw *G*, placed in the ear *l* on the opposite side of the ring. The spring *j* tends to force the lever *F* away from the diaphragm and against the adjusting screw *G*.

The ear *l* supporting the adjusting screw *G*, is drilled and slotted as shown in Figs. 1 and 2, to prevent the screw from wearing loose.

The part of the lever *F*, which comes in contact with the screw, is inclined to the axis of the screw, as shown, so that when the screw is forced inwards, it will press the lever towards the diaphragm, and when it is withdrawn the lever will, by the tension of the spring *j*, be forced away from the diaphragm. The outer end of the screw extends into a hole *t* through the casing, and is fitted to receive a piston, by which it can be turned to adjust the lever to a desired position.

The pressure between the two electrodes, and against the diaphragm obviously depends upon the position given to the adjusting lever by the adjusting screw *G*, but it is obvious that as this pressure can be increased or diminished only by increasing or diminishing the tension of the spring *d*, the changes in the pressure by turning the screw will be much less rapid than they would be if the electrode was acted upon directly by the lever or the adjusting screw. Hence a proper adjustment of the initial static pressure between the electrodes can be much more easily obtained through

the agency of the spring *d* than without it. It will also be easily seen that this pressure will not be sensibly affected by any slight change in the position of the electrodes which might arise from the expansion or contraction of any part of the apparatus under a change of temperature. On the other hand it will be seen that if the diaphragm is thrown into the rapid but slight vibrations caused by sounds, the spring alone would yield to them so readily as to give but little change of pressure between the electrodes within the range of the vibrations, but by reason of the inertia of the weight, the tendency of the spring to follow the vibrations of the diaphragm will be checked, and a greater range of pressures between the electrodes will be obtained. At the same time it is easy to see that the changes of pressure will be very different from what they would be if the electrode was supported rigidly, and could not yield to the movements of the diaphragm.

I have before stated in substance that the main feature of my improvements will be obtained even when the electrode *e* is attached directly to the diaphragm, but it should be observed that an additional improvement is gained by supporting that electrode on an independent spring which keeps it in contact with the electrode *e*, for it not unfrequently happens when the intermediate electrode is attached directly to the diaphragm that a too rapid vibration of the diaphragm or some other disturbance in its vibrations will throw the other electrode out of contact with the intermediate electrode, and thus break the circuit; but in my construction, such irregular vibrations of the diaphragm will separate the diaphragm from the intermediate electrode *e* rather than separate the two electrodes from each other, and the circuit will not be broken.

For convenience in construction, when employing the independent spring *e* for the purpose just stated, I attach it to the same arm of the adjusting lever *F*, to which the spring *d* is attached, the two springs being separated by a piece of insulating substance *r*; but the spring *e* might be attached to any convenient portion of the instrument if properly insulated.

The wires for connecting this transmitting instrument with the receiving telephone are marked *w* and *w'*. I have, however, shown them as connected with the primary circuit of an induction coil *I*, in connection with which *s* and *s'* are the screw-cups leading to the

battery, while s' , s are screw-caps for connecting the line wires with the secondary circuit of the coil.

The use of the induction coil is not essential, and the wires w , w' may go at once to the receiving instrument. The wire w is connected directly with the spring arm c of the electrode e , as shown in Fig. 2. The wire w' is connected with one of the ears of the ring h , as shown in Fig. 3, which is in metallic connection with the electrode e' , as shown in Fig. 2.

I claim,

First. The method herein described for holding the diaphragm of a telephone by means of springs pressing against one of its surfaces.

[Second. A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm substantially as described.]

[Third.] SECOND. The adjusting lever f for regulating the tension of the spring d , which carries one of the electrodes (e'), and the initial pressure between the two electrodes e , e' , and against the diaphragm, substantially as described.

[Fourth.] THIRD. The combination of the two electrodes by means of springs acting against each other, substantially as described, to maintain the electrodes in contact when forced away from the diaphragm.

[Fifth.] FOURTH. [A] The yielding weight g [substantially as described] connected with the movable electrode e' , to resist the movement of the diaphragm and modify by its inertia the variation of pressure between the two electrodes, substantially as described.

Witnesses:

H. G. OLIMSTED.

FRANCIS BLAKE, Jr.

W. W. SWAN.

The words and letters in the claims in Italics inserted by amendment, Feb. 5, 1879.
The words in small caps inserted by amendment, May 10, 1879.

Part in brackets struck out by amendment, May 10, 1879.

NOTE.—The application of Blake was filed Jan. 3, 1879, and contained five claims,

as above. May 10, 1879, this application was divided, the 1st, 3d, 4th and 5th claims remaining in the original case as already amended, but renumbered as 1st, 2d, 3d, and 4th, and a new application of this date filed, covering the 5th claim. The original specification and claims above printed, with the amendments shown, constitute the case involved in these interferences, Nos. 2 and 3.

*Edisons evidence
Cases 2 & 3.*

Chinook,

Lumel M. Serrell
8 7 5

In the Matter of Interference on Tel-
ephones, Cases 2 and 3, Edison,
BLAKE, CHINOOK.

New York, April 9, 1880.

F. BLAKE, Jr., Esq., & CHAS. E. CHINOOK,
Esq.

Gents:—Please to take notice that on Tuesday,
April 13th, 1880, and at Menlo Park, New Jersey,
and before a competent notary, I shall proceed at
10 1-2 A. M., to take testimony in behalf of said
Edison. In the above-named Interferences the follow-
ing are the names of witnesses.

Charles Batchelor, Menlo Park; Martin Force,
Menlo Park; Thos. A. Edison, Menlo Park; John
Kruetz, Menlo Park; John Ott, Menlo Park.

You are invited to be present and cross-examine
said witnesses.

LEMUEL W. SERRELL
Attorney for T. A. Edison.

Service of a copy acknowledged April 9, 1880.

J. J. STORROW,
Counsel for Blake.
EDWIN H. BROWN,
Attorney for Chinook.

T. A. EDISON.

IN THE UNITED STATES PATENT OFFICE

BEFORE HON. COMMISSIONER OF PATENTS.

In the Matter of Interference between
the Application for Letters Patent
on Telephones of THOMAS A. EDISON, FRANCIS BLAKE, JR., and
CHARLES E. CHINMOCK.

Deposition of witnesses examined on behalf of
Thos. A. Edison, pursuant to annexed notice at the
laboratory of T. A. Edison, at Menlo Park, New
Jersey, on Wednesday, April 14th, 1889.

Present—L. W. SERRELL, Esq., on behalf of T. A.
Edison; J. J. STODOL, Esq., on behalf of
Francis Blake, Jr., and E. H. BROWN, Esq., on
behalf of C. E. Chinmuck.

THOMAS A. EDISON, being duly sworn, deposes
and says in answer to interrogatories proposed by L.
W. SERRELL, Esq., as follows:

1 Q. Please state your name, age, residence and
occupation?

A. My name is Thomas A. Edison, age thirty
three, residence Menlo Park, Middlesex county, New
Jersey; occupation inventor; I am one of the parties
to this interference.

(Counsel for Mr. Edison at this point enters
an objection to Mr. Chinmuck being considered
as one of the parties to the interference on the
first count of case No. 3, as Mr. Chinmuck has
not any graphite or similar material set forth
in his application in this interference.)

3 [T. A. EDISON.

(Counsel for Mr. Edison furthermore introduces a copy of Letter Patent No. 203,014,
granted April 30, 1878, the application having
been filed July 20, 1877, the same to be
marked "Edison's Exhibit Patent 203,014.")

(Objected to as irrelevant by counsel for
Chinmuck.)

2 Q. During the year 1877, about what portions of
your time was devoted to electrical appliances for
transmitting speech?

A. Nearly all my time.

3 Q. And how many assistants did you have, if
any, at work upon that subject?

A. Generally two engaged with myself in exper-
imenting with the apparatus made by workmen.

4 Q. I now read to you the subject matter of in-
terferences cases 2 and 3, as officially declared, and
ask you whether or not either of said subject
matters is found in Exhibit Edison's Patent 203,014?

(Objected to by counsel for Chinmuck, as in-
competent and irrelevant.)

A. Yes, sir.

5 Q. Please give your reasons and explain the op-
eration?

A. The springs *i. i.* had upon their extreme ex-
tremities in front of the diaphragm brass cups, in
which small cylinders of plumbago were secured.
These springs were adjusted to a point where the
surface of the plumbago came in contact with the
diaphragm, which resting upon it, closed the elec-
tric circuit. A rise and fall of tension in the electric
circuit was produced by the pressure upon the sur-
face of the plumbago, due to the sudden movement
of the diaphragm against the weighted spring.

6 Q. What part do you refer to as the weighted
spring?

A. The part marked *i. i.*

continue
203 014

203 014
same as
counts 2 & 3

- 13 7 Q. In the apparatus shown in this said patent 203,014, was there any portion that acted by inertia to modify the pressure between the two electrodes when made use of as a speaking telegraph?

(Same objection and as leading.)

- A. Yes, sir; brass cup and plumbago acted by inertia to produce pressure, for without inertia there could be no pressure; the amount of inertia or weight would in a degree modify the amount of pressure, there being a relation between the weight, its inertia and the power applied to move it to obtain results in a telephone.

8 Q. Please point out upon the patent 203,014 the parts corresponding to the 2d subject matter of interference in case 3, if you find the same therein as you have before intimated?

(Same objection.)

- 15 A. *e*, is the diaphragm; *k*, are the rings which hold the case; *h*, is the cylinder; *l*, is the flexible weighted circuit governor; *a*, is a screw for adjusting the spring *l*. The contact points are upon the ends of the springs *l*, *l*.

9 Q. Previous to applying for letters patent No. 203,014, had you constructed any speaking telephone or speaking telegraph containing the subject matter of either of the counts in cases 2 and 3 in this interference?

(Objected to as leading.)

A. Yes, sir. About in April, 1877, I made a telephone having a diaphragm; in front of this diaphragm were several springs similar to those shown in patent No. 203,014. On the extreme end of these springs were brass cups or shells; in these shells were cylinders of plumbago; the ends of the cylinders

17 deers of plumbago were all adjusted so as to be in contact with each other, and with the diaphragm of the speaking instrument, the circuit passing up one spring to the extremity holding the plumbago passed through it to the next plumbago, and so on through the rest of the cylinders to the spring furthest from the diaphragm, thence to the other pole of the circuit; the lower end of these springs were secured to blocks of brass, provided with slots, and these were all secured to a block of insulating material by screws, which passed through the slots, which admitted of adjustment of the springs up or down and to or from the diaphragm or the adjacent springs.

10 Q. Have you any drawing of this instrument?
A. Yes, sir; I have.

(Counsel for Mr. Edison offers the same in evidence, to be marked Edison's Exhibit 42—11.)

11 Q. Please state whether or not this instrument 10 which you have described, and which you have produced Exhibit 42—11 as illustrating, was ever made or used, and if so, with what result?

A. It was made and used, and worked well.

12 Q. When was this done?

A. Within one or two days, I think, of April 1, 1877.

13 Q. Who wrote upon this Exhibit "April 1, 1877," and when was it written?

A. It was written by me, I believe, at the time of so making the drawing and on that date.

14 Q. Have you been in the habit of preserving drawings and placing dates upon them, and if so, what has been your habit with reference to these dates in reference to ensuring accuracy of such dates?

A. Since 1877, the early part January or February, I have been in the habit of writing down in books or pamphlets ideas of experiments to be tried and

42 - 11

21 experiments that were tried, putting down the date at the time of making the drawing. These drawings were generally witnessed by some of my assistants at the time or within a short time afterwards.

15 Q. Who witnessed Exhibit 42-11, if any one?
A. My two assistants, Charles Butcher and James Adams.

16 Q. State whether or not Mr. Adams is now alive?

22 A. No, sir; he is dead. He died in London, England, about a year ago. I received, under date of May 5, 1879, a cable message informing me of his death.

17 Q. Please tell us which of the figures on Exhibit 42-11 illustrated the speaking instrument which you have described?

A. The figure at the top of the page, over the date.

18 Q. Please tell us which part in said instrument, if any, composed the yielding weight, connected with the movable electrode, to resist the movement of the diaphragm, and modify by its inertia the variation of pressure between the two electrodes?

A. The extreme end of the spring carrying the cup, a tale, and plumbago cylinder.

19 Q. Which part in the said machine, if any, contained the first subject of interference in case 3, viz.: the springs in combination with pieces of graphite, or similar material between them, and the diaphragm of a telephone instrument?

24 A. Any three of these springs meets this case.
20 Q. Which parts, if any, in said instrument contain the second count in int. 3, viz.: an electric circuit, a vibrating diaphragm, and a flexible weighted circuit governor?

(Objected to as leading.)

A. Any of the springs or the whole of the springs.

21 Q. Which part, if any, becomes the weighted circuit governor?

A. As the end of the springs are weighted, and as they govern the circuit, they must be weighted circuit governors.

22 Q. Have you any of the parts of the instruments shown on this Exhibit 42-11?

A. Yes, sir: I have two of the springs, but without the plumbago cylinders.

(Counsel for Mr. Edison offers these in evidence, to be marked "Edison's Exhibit springs, 42-11."

23 Q. Have you been able to find any other of the parts of the instrument shown on Exhibit 42-11?

A. No, sir.

24 Q. Did you at any other time make any other speaking telegraph containing the subject matter of any of the counts in these interference cases 2 and 3?

A. Yes, sir.

25 Q. Please describe the same.

A. About May 26, 1877, I made a telephone with three springs, the tips of which had platinum points secured to them. One of the springs was weighted upon its extremity to prevent the springs from vibrating excessively. These springs with their points were arranged substantially the same as shown in Exhibit 42-11, but in this case batteries were short circuited or shunted from the electric circuit at each vibration of the springs. Each spring had its own battery.

26 Q. Have you any drawing of that instrument, and if so please produce it.

A. Yes, sir.

(Counsel for Mr. Edison offers the said drawing in evidence, to be marked "Edison's Exhibit 106-11.")

spring
42-11

106-11

29 27 Q. Please tell us which, if any, of the counts in interferences 2 and 3 were contained in the machine illustrated by Edison's Ex. 106-11?

A. The spring furthest from the diaphragm being weighted, acts by inertia to resist the movement of the diaphragm, and having connection or being capable of controlling to a certain extent the electric circuit, it is a flexible weighted circuit governor. It corresponds with the count in case 2 and with the second count in case 3.

30 28 Q. In this instrument illustrated by Ex. 106-11 did you employ carbon or plumbago?

(Objected to as leading by counsel for Chin-
nock.)

A. No, sir; I used platinum points.

29 Q. I now show you a copy of the drawing in Mr. Chinnock's application now in interference and of his specification, and ask you to examine the same and state whether or not there is any substantial difference between Ex. 106-11 and the said Chinnock drawing, or in the operation of the parts, and 3 are concerned?

A. The action of the two instruments appear to me to be precisely the same. Both instruments have a weighted circuit governor and a spring not weighted. Both have springs with platinum points. Both have springs set in motion by the diaphragm.

32 Both disturb the circuit by causing such springs to shunt a battery. The only difference that I can see is a difference in design and size of parts and extra spring on the instrument of Exhibit 106-11 and the use of these batteries in place of one. I think the lesser is in the greater.

30 Q. If the 1st count in case 3, in which graphite or similar material is spoken of as one of the elements, is to be construed as including the platinum contact points in Mr. Chinnock's instrument, does

or not your instrument shown on Ex. 106-11 also include the 1st count in said case 3?

A. No, sir; it does not. It has no plumbago, and plumbago is not similar as a material to platinum.

31 Q. If the Patent Office, in acting on this interference, should rule that platinum contact points and carbons were similar, would the subject matter of the 1st count in Int. 3 be found in the instrument represented in Ex. 106-11?

A. Yes; if they really so ruled.

32 Q. Did you ever make use of the instrument represented in the Ex. 106-11; if so, when and to what extent, and with what results?

A. Yes, sir; about May 26, 1877, with very poor results. Commercially speaking, no results.

33 Q. Please tell what difficulties you experienced?

A. Experienced difficulty in transmitting words which could not be recognized when the receiving operator knew what they were.

34 Q. Did you discover to what this difficulty was attributable?

A. Yes, sir; some of the difficulties we discovered. One of the difficulties was to keep the instrument adjusted always at the same degree. Another difficulty was that ordinary platinum points when pressed together do not modify the circuit to such a degree, or in such an even manner as to render waves produced by such compression of sufficient amplitude, or of sufficient evenness to be reproducible, with any degree of reliability, by any telephone instrument for utilizing such waves.

35 Q. When was the date put on Exhibit 106-11, and by whom, if you know?

A. I believe it to have been put on at the time that it was dated, by myself.

36 Q. Did you make any other telephone or speaking telegraph containing the subject of either of the counts in these interferences?

difficulty of adjustment

106-11

Chinnock

37 A. Yes, sir; I did.

37 Q. Please describe the same, and produce any sketch or drawing you may have of the same?

112-11

A. I have a drawing here dated May 31, 1877, drawn and dated by myself at that time, and witnessed by Charles Batchelor and James Adams, my two assistants. The apparatus shown in this Exhibit (which is marked Edison's Exhibit 112-11, and offered in evidence,) is provided with a diaphragm. In front of the diaphragm are two springs, with plumbago between them.

38 Q. Please tell when this instrument was made and whether you used the same, or endeavored to use it and how, and with what results?

A. The instrument was made about May 31, 1877. The two springs pressed against the plumbago cylinder between them and preserved the continuity of the circuit, which passed from one spring through the plumbago, to the other spring. The diaphragm pressing against these springs produced a rise and fall of tension in the circuit. The large spring, which was a sort of a vibrating reed, was made adjustable so as to press with more or less pressure upon the diaphragm. It had some elasticity, and was very heavy, so heavy that it would not to any great extent follow the rapid motions of the diaphragm in vibrating. The difference in pressure was mainly produced by the inertia of this large bar, or incapacity to move with the same rapidity as the diaphragm, subsequently, perhaps within 2 or 3 days after making

40 front of the diaphragm, the extreme end of the spring in its vibrating period so much a low point as to be incapable of responding to the vibrations of the diaphragm, or any lower multiples of the same.

40 Q. Have you any portions of the instrument shown on Exhibit 112-11.

A. I have here some of the weights used upon the extremity of the spring or reed, and also one of the

cuys holding plumbago, which was upon the end of 41 the spring. I had the spring itself within the last three months, but it has been mislaid. The spring was about five inches long from the clamping post, about 3-8 thick and 5-8 broad.

(Counsel for Mr. Edison offers these weights in evidence to be marked "Edison's Exhibit Weights, 112-11.") Also the cup and carbon to be marked Edison's Exhibit cup and carbon 112-11.

40 Q. To what extent, and with what result did you make use of the instrument shown in Ex. 112-11?

A. The instrument worked very well. We worked with it for perhaps a week.

41 Q. Please examine the subject matter as stated in cases 2 and 3 and state which one, if either, is found in the instrument shown on Ex. 112-11?

A. In case 2, it is relative as there was a yielding weight connected to a movable electrode to resist the movement of the diaphragm, and modify by its inertia the variations of pressure between the two electrodes. It is relative to case 3, inasmuch as there are springs with graphite between them and a diaphragm. It is relative to the 2nd count in case 3, as there is a vibrating diaphragm and a flexible weighted circuit governor.

42 Q. Did you make any other instrument containing the 2nd count in case 3, if so, please produce any evidence thereof, and describe the construction and operation?

A. Yes, sir. I have here a drawing dated July 5, 1877, the drawings and date written by myself at the time, witnessed by Charles Batchelor and James Adams, the same being offered in evidence and marked Edison's Exhibit 2-12. I will now describe the middle figure on this Exhibit:

An upright cylinder had on its upper face a

112-11
contains
cases 2 & 3

2-12

45 diaphragm secured to its end, the lower end was closed and had a mouth-piece, suitable for speaking in. In the centre of the diaphragm there rested a disk of plumbago marked P. in the Ex. Four pins extended outward from the plumbago, a short distance, to which strings were secured. The other ends of the strings were secured to the outer periphery of the diaphragm. The object of these strings was to hold it lightly on the diaphragm, and to prevent its moving away from the centre of the diaphragm sideways. The disk was also held upon the diaphragm by gravity. The diaphragm was connected to one pole of the circuit, while the disk of plumbago was connected to the other pole of the circuit. Variations in pressure between the surface of the plumbago and the diaphragm was made when the latter was vibrated. This variation took place, or depended almost entirely upon the inertia of the disk of plumbago. It is relative to the 2d count in case 3, as there was a vibrating diaphragm and a flexible weighted circuit governor. The circuit being varied or modified by inertia.

47 Q. Please tell us when this instrument was made, and whether it was used, and with what success?

A. I think it was made within a week or two of July 6, 1877. The instrument worked well.

48 Q. Did you make any other telephone instrument containing the subject of the 2d count in Int. 3?

A. Yes, sir. I have here a sheet dated July 7, 1877, written at the date by myself, and witnessed by Charles Batchelor, and offered in evidence marked Edison's Exhibit G-13.

45 Q. Please describe the middle diagram on that sheet, and tell us whether the instrument represented thereby was ever made, or used, or with what result?

A. The instrument shown in Ex. G-12, is almost

like the one shown in 2-12, the difference being that a single thread is there shown, and the ends brought nearer to the center of the diaphragm, the action is practically the same. The instrument was made about the same time as that shown in Exhibit 2-12. Perhaps the same instrument was used to try this modification upon it, as we were in the habit of trying a great number of devices with the same chamber and diaphragm. One instrument being broken up or used, or parts used to try experiments on other forms of apparatus.

46 Q. Can you produce any other drawing of any instrument made by you containing the subject matter of either of the counts of this interference?

A. Yes, sir. I have here a drawing, written and dated by myself Sept. 21, 1877, witnessed by Charles Batchelor, containing four diagrams.

(The same is offered in evidence marked Edison's Exhibit 165-12.)

47 Q. Please describe the devices therein represented?

A. I now mark the diagrams on this Exhibit No. 1, 2, 3 and 4.

No. 1 shows a diagram near the centre of which there are four thin pins, between these pins, is a disk of plumbago, having flanges cut upon it, through these flanges were holes through which the four pins passed. A spring was secured near the outer periphery of the diaphragm, which served to press the plumbago against the diaphragm. In this diagram No. 1 is a note, which says: "working by momentum no adjusting screws," this instrument I do not think was made. In diagram No. 2, is a diaphragm in the centre of which is fixed a piece of metal, upon this metal there was held a piece of plumbago, by means of a thread; upon the outer surface of the plumbago was a concave paper disk, the object of which was to resist the sudden movement of the

G-13

165-12

plumbago, when an outward movement of the diaphragm took place, thus modifying the degree of pressure between the plumbago and the diaphragm both by the inertia of the plumbago, and the resist-
 ance offered to the sudden compression by the paper disk, the connection was made as in Exhibit 2-12 the diaphragm being connected to one pole of the circuit and the plumbago to the other. This apparatus worked well. The diagram No. 3 shows a slight modification. I herewith produce the diaphragm
 64 which I believe was used in the experiment No. 3.

(The same is offered in evidence marked Edison's Diaphragm 165-12.)

The diaphragm No. 4 is similar to that shown in Exhibit 2-12, the difference being that the plumbago was held against the diaphragm by means of spiral springs. I am not sure that I made the modifica-
 65 tions shown in No. 4.

48 Q. Can you produce any other drawing showing the subject matter of either of these interferences?

A. Yes, sir; I have here a sheet dated by myself Sept. 30, 1877, witnessed by Charles Batchelor containing several diagrams working upon the same principle substantially as that shown in Exhibits 2-12 and 6-12 and 115-12.

(The same is offered in evidence and marked Edison's Exhibit 188-12.)

40 Q. Please describe the construction and operation of the respective devices therein represented?
 A. I now number the parts Nos. 1, 2, 3, 4 and 5, the description of No. 1 will apply to all.

No. 1 consisted of a cup made of vulcanized rubber, secured to the centre of the diaphragm, over

this cup was another cup, which was larger and served to pass over the cup upon the diaphragm, in fact adjustable so that its outer end could be made to approach and recede from the diaphragm by a screw thread cut from the outer periphery of the diaphragm cup and the inner periphery of its cover. In the bottom of the cup was placed a disk of silk coated with plumbago; over this was placed a weight; on this and reaching from the weight to the bottom of the cup was a large spiral spring, which served to connect the weight with the electric circuit, the weight being one of the electrodes, and also served as a variable presser, the screwing in or out of the larger cup increasing or diminishing the initial pressure of the electrode upon the plumbago tuft. The diaphragm being connected to the other pole of the circuit, the variations in the strength of the current was brought about when the diaphragm was vibrated by a greater or lesser pressure due to the inertia of the weight forming one of the electrodes. This apparatus was made about the time at which the drawing was made, and worked well. The same apparatus is shown in my British patent of 1877, July 30, and numbered 2,800. By diagram marked fig. 17, the specification of this patent relating to that subject and figure, reads as follows on page 9, lines 42 to 54, inclusive: "In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympanum 10, fig. 17, a small cylinder, 7, of hard rubber or non-conducting material, within which is the fibrous tension, regulator 6, resting upon a piece of platinum foil connected to one pole of the battery, and within this cylinder, 7, is a disc, 110, of iron or other metal, loose, but pressed towards the tension regulator by a spring, 15, and screw cap, 16, and the other electric conductor is connected with said spring. The inertia of the metal disc causes more or less compression of

*Exp. 188
2719.
July 30, 1877*

188-12

- 61 the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disk, 70, to a yielding spring, 71, that extends across from one edge of the diaphragm to the other, as seen in fig. 16. This construction of tension regulating device is especially available with large diaphragms. This specification was signed by me on the 24th day of December, 1877. The originals from which the specifications were prepared were furnished to Mr. Serrell some time before the signing aforesaid.

- 62 50 Q. Have you here present any memorandum by which to determine the original date when said specifications were furnished to Mr. Serrell?

A. I do not think I have anything.

- 63 51 Q. Did you at any time construct a telephone instrument with a piece of graphite, or similar material between two springs, in combination with a diaphragm, other than those you have mentioned?

- 64 A. Yes, sir. I have here a sheet dated October 4, 1877, drawn and written by myself and witnessed by Charles Batchelor, in which there are two springs with carbon between them. The apparatus consists of a diaphragm with a central point secured to its centre, this point serving to separate the two springs, which were placed at right angles to the diaphragm, and thus relieve the pressure upon the carbon by the two electrodes which were connected in circuit. I herewith produce the diaphragm which I think was

(Drawing offered in evidence marked Edison's Exhibit 17-13, and the diaphragm offered in evidence marked Edison's Diaphragm 17-13.)

- 62 Q. Counsel for Mr. Edison offers in evidence a mica diaphragm marked Edison's Exhibit Mica Diaphragm, and he is asked whether or not diaphragms

of that kind, with the appliances thereto, have ever been made and sold—if so, when and to about what extent?

A. Yes, sir; they have been made. I think an order for several hundred was started in June, 1879, for a London Telephone Company. A large number were shipped there.

- 63 Q. Do the same contain the subject matter of either of the counts in this interference?

A. They contain the subject matter of case 2, and in the second count of case 3.

- 64 54 Q. Was there more than one instrument made like that shown on Exhibit 188-12—state whether you remember?

A. Of that exact form and design, I don't think there was more than one made.

- 65 55 Q. Can you produce any portion of the original instrument shown in your Letters Patent 263,014?

A. No, sir; but I can produce a spring having upon its end a brass cup and a plumbago contact point, which was used in some experiments in 1877, about March, I think.

(Said spring is offered in evidence, to be marked "Edison's Exhibit Spring, March, 1877.")

Examination adjourned to Thursday, April 16th, 1880, at 10 1-2 o'clock A. M.

S. L. G., Notary. 08

*Mica dia
June 1879*

*Spring
March 1877*

7-13
Diaphragm
7-13

69 LABORATORY OF T. A. EDISON,
MELRO PARK, NEW JERSEY,
Thursday, April 15th, 1880.

Met pursuant to adjournment.

Counsel present as before.

Continuation of examination of T. A. Edison,
by L. W. Serrell, Esq.

70 56 Q. Please examine the Exhibits 42-11, 106 11,
112-11, 2-12, 6-12, 103-12 and 188-12 and 17-13, and
state whether or not any changes or additions of any
character have been made to said Exhibits since they
were originally made, except the marks and num-
bers which have been made for the purposes of this
examination?

A. No, sir; I do not think or believe any change
has been made other than those given in the ques-
tion, except some numbers on the top left hand cor-
ner of some of the sheets made by a person who took
71 tracings of these drawings on tracing paper. There
has been, in some cases, spots of ink on the paper
which passed through the tracing cloth. I notice
these spots on nearly all of the Exhibits. They are
specially noticeable on Ex. 42-11.

57 Q. Do those spots of ink in any manner change
the drawings, or interfere with their being clear re-
presentations of what they were originally intended
72 to show?

A. No, sir; I do not think they do.

58 Q. In whose possession have these Exhibits
been since they were originally drawn, or under
whose control have they been, and where have they
been?

A. They have always been under my control, but
they have been in charge of my bookkeeper, Wm.
Carman, and in the hands of Mr. Griffin, my secre-
tary. They have also been in the hands of Mr.

Serrell, of New York, for some time, they being
taken there for the purpose of examination in con-
nection with interference testimony soon to be taken.

59 Q. Some of these Exhibits have been injured
on their upper edges. How did that arise?

A. They were torn out of books of the size of the
cover which I now produce.

60 Q. Why were these torn out, and when?

A. They were torn out so that experiments relating
to the same subject might have their records placed
together. Every experiment having generally a 74
title indicating what it was. It was done over a year
ago, I think. My bookkeeper, Mr. Carman, will be
able to give the probable date.

61 Q. Do you remember whether there was any-
thing being done at this time, when these drawings
were being torn out that rendered it important to
select the records relating to particular subjects, and
bring them together?

A. Yes, sir; I expected that they would be used
in the interferences on the telephone. I also desired 75
to make tracings, so that they could be kept apart
for safety.

(The cover referred to introduced as a cover for
the Exhibits.)

62 Q. Please now examine each of the Exhibit
drawings referred to, and state whether or not the
drawing upon each Exhibit was made at the date
designated upon that Exhibit, and whether that
drawing is still the same as it was at the date shown
upon that Exhibit?

(Objected to by counsel for Chinmuck as
leading.)

A. I believe that every drawing was made on the
date written upon the paper, and I do not think any
changes whatsoever have been made in the draw-
ings. There has been instances where drawings
were made, and a date and title was not written

77 down, but always within three or four days the date was placed upon the paper, which date was the date written, hence the diagrams would in this case be made before the date upon them. These books were scattered all over the laboratory, so that if I wished to express an idea, or explain a movement or design to an assistant, I would pick up a book nearest by, write the title, date it, put my name down, and make the drawings. When the book was full, they were collected together and fresh book or books scattered around the laboratory. We had been taught by numerous interferences, the value of these records, and the necessity of figuring in books, in place of separate scraps of paper, which were very liable to be lost.

63 Q. Are all of the sketches and drawings which you have, dated and witnessed, or have some of these precautions been overlooked or omitted?

A. I have many drawings taken from these books which are neither witnessed nor dated, but the majority are both witnessed and dated.

64 Q. Since the examination yesterday, have you found any more of the Exhibit springs 42-11?

A. Yes, sir, I have found one more, which I now produce.

(This spring is now tied in along with the two that were produced yesterday.)

80 *Cross-examination by E. H. Brown, Esq., counsel for C. E. Chubbuck:*

65 X Q. How long was the apparatus illustrated by Edison, Exhibit No. 42-11, in use?

A. I should think about four or five days.

66 X Q. Who used it?

A. James Adams, Charles Batchelor, and myself.

67 X Q. Where?

A. In the laboratory at Menlo Park.

68 X Q. What was done with it then?

A. I think the board with the springs upon it 81 were laid aside, and the drum and diaphragm used for other improvements.

69 X Q. Can you give me the dimensions of the parts approximately?

A. The dimensions of the springs parts is shown in the Exhibits. I cannot remember the exact size of the drum and diaphragm, as we had several which were used in experimenting. My impression is that the diaphragm was larger than three inches in diameter, and not greater than perhaps seven inches in diameter; as we had several drums with diaphragms of different sizes, I could not with certainty give the size.

70 X Q. When next after that instrument was taken to pieces, did you see the springs Exhibit 42-11?

A. I think I saw them about July, 1878.

71 X Q. Are you positive of this or is it a mere impression?

A. I am not positive about the exact date, but I remember having these springs hunted up for some purpose connected with my controversy with Hughes, who claimed that I never used a number of carbons.

72 X Q. Where were they found then?

A. I don't know where they were found. They were found by one of my assistants, probably in the scrap.

73 X Q. When next did you see them?

A. I don't remember of seeing them since until yesterday.

74 X Q. Where were they found then?

A. I did not find them; one of my assistants found them.

75 X Q. Then you don't know where they were found?

A. They were found in the laboratory, but what part I don't know.

76 X Q. You say you had these springs hunted up for some purpose connected with your controversy with Hughes, was that a controversy in print?

85 A. Yes, sir, it was, most of it.
77 XQ. Published in any newspapers or periodicals?

A. Yes, sir.

78 XQ. Will you name all of such newspapers and periodicals that you now remember, giving their dates as near as possible?

A. The controversy was carried on from July, 1878, for many months in the columns of the London Enquirer, London Engineering Nature, published in

80 London; Telegraphic Journal, published at London; the Electrician, published at London; Scientific American, and many other papers.

79 XQ. Did you ever make another instrument or apparatus of the kind illustrated in Exhibit 42-11?

A. Yes, sir; I have made them in which there were platinum points used instead of carbon, but the action as regards the circuit was a little different.

80 XQ. How many of such instruments and when?

87 A. I believe I made an instrument with multiple points of platinum about April 1, 1877. One of these instruments is shown in the lower diagram on Exhibit 42-11; still another one is shown in Exhibit 106-11.

81 XQ. If you did make an instrument like that in the lower diagram of Ex. 42-11 how long was it in use, if at all, by whom, where, and what became of it?

88 A. I don't think it was in use any more than a day, as the results were very poor. The instrument, I believe, was made and worked at the Laboratory at Menlo Park, within a few days of the date marked on the exhibit.

82 XQ. Did you ever make or have made a second instrument precisely like either of the instruments shown in Ex. 42-11?

A. Yes, sir; I think I made one, as I said before, about May 20, 1877.

83 XQ. Do you mean the one shown in Ex. 106-11?

A. Yes, sir.

84 x Q. Any other?

A. Yes, sir; something similar to the top diagram on Exhibit 42-11. This is shown in Exhibit 17-33.

85 x Q. Any other?

A. A similar transmitter to that shown in Ex. 106-11 is shown in my Patent 208,200, application filed July 20, 1877.

86 x Q. Were the sketches in Exhibit 42-11 made before, or after the instruments shown by them were made?

90 A. I think they were made before the instruments. My impression is very strong that they were made before the instruments were made.

87 x Q. Who made those instruments?

A. I think the springs of the top diagram were made by Mr. Adams. The bottom Exhibit I don't know who made, my impression is that it was made up from parts taken from an acoustic instrument. I could not say who made the case and diaphragm.

88 x Q. What results were attained with the instruments shown in the upper sketch or diagram in Exhibit 42-11?

A. Good results.

89 x Q. About how far did the platinum cylinders project from the brass cup?

A. My impression is that they projected, perhaps 1/32 of an inch although it would be hard to say after this lapse of time.

90 x Q. Did you ever make any publication of an instrument exactly like that shown in the upper diagram of Exhibit 42-11?

A. Yes, sir, I believe it was published in Mr. Prescott's work on Electricity, Telephones, &c. 91 x Q. When?

A. I think the book was published in 1879.

92 x Q. Are you sure it was so published?

A. Yes, sir. I am sure it was published in 1879. At least that is the date on the book. The diagram shown in his book is practically the same thing, but

*Patent
208,299*

*42-11
9000
110000*

93 the draughtsman has altered its design, to make it look more symmetrical, I suppose.

93 x Q. What is the exact title of the book to which you refer?

A. The Speaking Telephone, Electric Light and other recent electrical inventions, published by Geo.

B. Prescott, in 1879. The figure is 290, page 531.

94 x Q. How long was the instrument illustrated in Ex. 100-11 in existence?

A. My impression is that not more than a day or two.

95 x Q. How long was it in use?

A. Perhaps several hours.

96 x Q. Did you ever make another exactly like that?

A. Not exactly like it. I made another one, substantially like it, or illustrative thereof for a model for an application filed July 20, 1877, the same being the patent granted to me No. 268,200.

97 x Q. Was Exhibit 106-11 made before or after the instrument which it illustrates?

A. I think it was made within a day or two of the date on the Exhibit. The instrument was made a day or two after the sketch.

98 x Q. Who made that instrument and where was that used?

A. I can't remember who made the instrument. It was used at my laboratory at Menlo Park.

99 x Q. Did you ever make a publication of that specific instrument?

A. I do not think a diagram of that specific instrument was ever published.

100 x Q. How long was the instrument as a whole shown in Exhibit 112-11 in existence?

A. Perhaps as much as a week.

101 x Q. What was done with it then?

A. I think the diaphragm and drum were used for other experiments, the platinum spring used up for other experiments, the other parts thrown in the scrap heap.

102 x Q. Where did you find the Exhibits cup and carbon and the Exhibits weights 112-11, and when?

A. The cup of carbon was found by one of my assistants, I think about three or four months ago. The weights were found by one of my assistants yesterday. He found them in the laboratory, where, I do not know.

Adjourned for lunch.

103 x Q. Who made, and who used this instrument shown in Exhibit 112-11?

A. I cannot say who made it. It was used by Adams, Batchelor and myself.

104 x Q. Do you recollect the size of the diaphragm in that instrument?

A. My impression is that it was about three inches.

105 x Q. Was the diagram Exhibit 112-11 also made before the instrument which it shows was made?

A. I think the diagram was made before the instrument was made.

106 x Q. Did you ever make, or cause to be made any other instrument like the specific instrument shown in Ex. 112-11?

A. No; not exactly like that instrument, but I have made others substantially like it.

107 x Q. Where was the instrument shown in Ex. 112-11 used?

A. In the Laboratory at Menlo Park.

108 x Q. In speaking of other instruments substantially like that, do you refer to the instruments shown in any other of your Exhibits herein?

A. No, sir.

109 x Q. When were those instruments which you say were substantially like that one, made?

- 101 A. About Sept., 1877.

110 x Q. What became of them and how many were there?

A. I think there were five or six made. I think they were thrown in the scrap as not commercially suitable.

111 x Q. How long were these five or six in existence?

A. I can't say, but my impression is that they were used up in other experiments. Perhaps within a month or two from the time they were abandoned as unsuitable for practical work.

- 102 112 x Q. Did you ever make any publication of that instrument shown in Exhibit 112-11?

A. I do not think I ever did, made exactly as shown in the Exhibit. I made publication of an instrument with a platinum spring resting on plumbago, and that again resting on a solid adjustable shaft. The solidity of the shaft being compensated for by a rubber spring placed between the platinum and the diaphragm.

- 103 113 x Q. When and where?

A. I think that 200 instruments were made, or started to be made, in December, 1877. I think in September, 1877, that 25 or 30 were also made—the latter being made at my shop at Menlo Park, and the others being made by J. T. Murray, 10 and 12 Ward street, Newark, New Jersey.

- 104 (Objected to as irrelevant, and question repeated.)

Witness proceeds:

I think the first publication was made in the Journal of the Telegraph in about April or May, 1878, and also in Mr. Prescott's book published in 1878, I refer to the Journal of the Telegraph dated April 16, 1878, vol. 11, page 114. I refer to fig. 2 as illustrating the Telephone, and to fig. 1 as illustrating

the principle, and to Mr. Prescott's book published in 1878, page 35, fig. 30, page 36, fig. 31, manuscript and diagrams for this book furnished Mr. Prescott two or three months before the publication in the Journal of the Telegraph. The title of the book is "The Speaking Telephone, Talking Phonograph and other Novelties," by Prescott.

114 x Q. Am I to understand that you are not certain whether the 200 telephones were completed?

A. I am not certain whether the whole of the 200 were finished, but I think about 100 were finished.

115 x Q. Have you or not on hand all that were completed?

A. Of the order given to Mr. Murray, I think that the ones he did deliver are nearly all in my possession, except some which I think were delivered to the Western Union supply department at New York, but I am not certain whether these were sent back to me at Menlo Park.

116 x Q. What became of the 25 or 30 which you made?

A. I think we have some of them on hand now; others were perhaps used in experimenting.

117 x Q. Are any of these 25 or 30 or any of the 200 instruments in use now?

A. I do not think so.

118 x Q. How long were they in use, if ever?

A. I think that two pair were put in use in New York, and were in use for several weeks; I have never seen them since they were put in use, except about three weeks afterwards.

119 x Q. How long was the instrument shown in Exhibit 2-12, in use?

A. I don't think more than a day or two.

120 x Q. What became of it?

A. I think the diaphragm and cylinder were used for other experiments, the plumbago, I don't know what became of it.

121 x Q. Who made that, and where was it used?

Journal of
Telegraph

Apr 16-78

- 100 A. I don't know who made it. It was used at Menlo Park by Batchelor, Adams and Edison.
122 x Q. Did you ever make any other instrument like the specific instrument shown in Exhibit 2-12?
A. Not exactly like it, but substantially like it.
123 x Q. When substantially like it?
A. In Exhibit 6-12, central figure. In Ex. 188-12, figs. 1, 2, 3, 4. In Ex. 165-12, figs. 1, 2, 3, 4.
124 x Q. Any others?

A. Yes, sir.

- 110 125 x Q. When?

A. I think about the same time I made a great number of experiments, when the whole of the circuit governing devices was placed upon the diaphragms, they were modifications of those shown in the Exhibits above mentioned. I also made or started to have made, I think in June, 1879, a large number of telephones made substantially as in Exhibit marked Edison's Exhibit Mica Diaphragm.

- 126 x Q. How long did those remain in existence, except such as were like Exhibit Edison Mica Diaphragm?

A. I do not think they were in existence as a combination, perhaps more than a week.

127 x Q. Where were they made, and used, if used at all?

A. I think I have testified already that they were made at Menlo Park.

128 x Q. And used there?

- A. And used there.

129 x Q. Did you ever make any publication of the specific instrument shown in Exhibit 2-12?

A. I have made printed publication in Mr. Prescott's book in 1879, figs. 266, page 628, and figs. 267, page 629. In the British Patent, No. 2,909, fig. 17.

130 x Q. Was this sketch in Exhibit 2-12 also made before the instrument?

A. I think it was.

131 x Q. How long did the instrument shown in Exhibit 6-12 remain in existence?

June 1879

Mica dia

Eng part

2909.

Fig 17.

A. I think the combination was broken up immediately after the instrument was made and tried, perhaps a day or two.

132 x Q. That was also made and tried at your laboratory at Menlo Park, was it, if so, by whom?

A. It was made and used at Menlo Park. I don't know who made it. My impression is, it was either Mr. Batchelor or Mr. Adams, and used by Edison, Batchelor and Adams.

133 x Q. How long did the experiment with that last?

A. It would be hard to say after this lapse of time, perhaps an hour, perhaps a day.

134 x Q. The sketch of that instrument in Exhibit 6-12 was also made before the instrument, was it?

A. I believe it was. What I mean when I say instrument, I mean the combination of the various parts to make a telephonic transmitter. The same diaphragm and chamber would have placed upon it, perhaps, a dozen different modifications, carrying out a method, sometimes in the space of ten hours.

135 x Q. Have you ever made any other instrument like the specific instrument shown in Exhibit 6-12, except such as have been already mentioned?

A. I do not think that I ever duplicated the instrument shown in Ex. 6-12 exactly.

136 x Q. How long did the instrument shown in 165-12 remain in existence?

A. The combination I do not think remained in existence more than a few days. I have here a part of an instrument like fig. 3, Ex. 165-12, marked Edison's Exhibit, Diaphragm 165-12.

137 x Q. By whom and where was that instrument made, and by whom, where and how long was it used?

A. By the looks of the exhibit I think the diaphragm was made by Adams at Menlo Park. It was used by Adams, Batchelor and myself for perhaps not more than several hours at my laboratory at Menlo Park.

- 117 138 xQ. How long were the other instruments shown in Exhibit 165-12 in existence and where and by whom made and used?

A. I think the instrument shown in No. 1 and No. 4 were not made. I feel sure that No. 4 was not made, but am not certain about No. 4. The instrument No. 2 I think was tried about the same time as that of No. 3, by the same persons and at the same place. I don't think they remained in existence more than a day or so.

- 118 139 xQ. Were the sketches for such of the instruments in Exhibit 165-12 as were made prepared before or after the making of said instruments?

A. My impression is they were made before.

140 xQ. Did you ever make another instrument of any of such instruments illustrated in Ex. 165-12 as were made except such as may have been heretofore mentioned?

A. I think I made no exact duplicates of the instrument shown in that exhibit.

- 119 141 xQ. Where did you find Edison's Diaphragm 165-12?

A. It was found by one of my assistants in the laboratory at Menlo Park.

142 xQ. How did the apparatus shown in Exhibit 188-12 work as compared with those of which you have testified previously made?

A. I think that it worked a little better than any of those in the other exhibits where the circuit governing devices are entirely on the diaphragm. Plumbago as well as carbon lamp black buttons were used between the electrodes.

- 120 143 xQ. To which of the instruments illustrated in your exhibits did you refer to in your last answer in comparison with Exhibits 188-12?

A. To that class of instruments where the circuit governing devices are entirely on the diaphragm, such as are in Exhibit 6-12, 2-12, 165-12.

144 xQ. How did it compare in its working with the other instruments shown in your exhibits?

- A. That would depend on what is the standard of comparison.

145 xQ. Please make the comparison with respect to loudness and distinctness of articulation?

A. The instrument shown in 188-12. When a plumbago button is used, or when the silk coated with plumbago is used was not so loud as the instrument illustrated in Ex. 119-11, but the articulation was about the same, that comparison of course is made at that state of the art. The instrument shown in 42-11 was louder but not so clear as that shown in Exhibit 188-12.

The instrument shown in Exhibit 108-11 was exceedingly loud, and just as indistinct. The instrument shown in the lower fig. of Ex. 42-11, I can't remember anything except that it did not work to such an extent as to give anything like the results desired.

146 xQ. Can you give me the dimensions of the diaphragms which were used in Exhibit 2-12, in Ex. 6-12, in Ex. 165-12, and in Ex. 188-12?

A. My impression is that they were 2 inch or 2 1/2 inch diaphragms.

147 xQ. Did you ever make another instrument as a whole, like the instrument shown in Ex. 188-12?

A. My impression is that I made a rough instrument and a good instrument.

148 xQ. Are you sure you did?

A. I am pretty sure I did.

149 xQ. Are you or not absolutely positive?

A. No; I am not positive.

150 xQ. How do you figure the date the 24th day of December, 1877, that you signed the specification for your English patent?

A. I figure it by the date in the printed patent?

151 xQ. How long was the instrument shown in Exhibit 17-13 in existence?

A. Perhaps not more than a day, that particular combination and that design.

105 152 x Q. Where and by whom was it made and used?

A. I can't say who made it. It was made at Menlo Park, and I think myself, Batchelor and Adams used it at the Laboratory.

105 x Q. Where was the diaphragm 17-13 formed and by whom?

A. It was formed in the Laboratory at Menlo Park by one of my assistants, yesterday I think.

100 154 x Q. Were all or any of your instruments shown in your exhibits, made and experimented with, for musical telephones or for speaking telephones?

A. They were experimented on entirely for speaking telephones.

155 x Q. Did you never make or experiment with any telephone instrument embodying any of the inventions in controversy for a musical telephone?

A. None of the instruments shown in these Exhibits were intended for musical telephones. I have made musical telephones with a platinum point facing a diaphragm. I have also made musical telephones with a platinum surface on a rubber spring, secured to a rigid point on the diaphragm, and I have made musical telephones with a spring having upon its end a platinum point in combination with a diaphragm.

100 x Q. Were the instruments, having diaphragms and apparatuses, like Edison, Exhibit mica diaphragm in practical use for any length of time?

A. Yes, sir; they were put in practical operation 108 in London, and, I believe, a few may be working now, the majority were abandoned in favor of the other form of carbon telephone used now generally.

157 x Q. When were the majority so abandoned?
A. I think some time in November or December, 1879.

158 x Q. And when were they furnished to the London Telephone Co.?

A. I think they were shipped either in August or September, 1879.

*Musical
Telephone*

*Mica dia
in use*

159 x Q. Please be a little more definite as to the kind of instrument which superseded them?

A. The instrument which superseded it is shown in Prescott's work. The Speaking Telephone, Electric Light, and other recent inventions of 1879, page 567, figs. 343, except as to some small changes in the design, the transmitters were identical as in fig. 363.

160 x Q. Were the instruments referred to in Int. 156 successful?

A. They were successful in one sense, but not in a comparative sense with the transmitters then in general use, but that is a matter of opinion.

161 x Q. When were the tracings made which you referred to in your 56th answer?

A. I cannot give the date of each tracing, the person employed in tracing was at it off and on for perhaps a period of six or eight months. I think the tracings were finished up more than a year ago.

162 x Q. Who made them?

A. Mr. Curran,

163 x Q. Is he in your employ?

A. Yes, sir. My bookkeeper.

164 x Q. They were made since the Exhibits were torn from the books, or pamphlets, were they not?

A. Yes, I think they were.

165 x Q. Have you not entered a disclaimer to some of the devices referred to in your British Letters Patent?

A. Yes, sir, I have.

166 x Q. To which of the devices embraced therein and when?

A. I don't know what particular devices. The disclaimer, I believe, was made some two or three months ago, the whole matter was drawn up in London by English Patent lawyers, to the end that under the peculiarities of the English law the Patent could be made valid, as the rules of the English Patent Office were not conformed with when the patent was applied for. Nothing was disclaimed, if I remember, because it had been previously invented

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1331 by others, when the specifications were read by the aid of the claims appended to the Patent.

167 x Q. Where you have stated in your testimony that your instruments have been used at Menlo Park without mentioning the place in Menlo Park where they were so used, did you or not mean that they were used at your laboratory in Menlo Park?

A. I meant at my laboratory, or between my house and the house of Mr. Adams, and the depot at Menlo Park, and the laboratory, and the laboratory itself.

134 168 x Q. When first had you knowledge that there was on the market, or in practical and public use telephone instruments like that illustrated in the drawing which I now show you?

(Drawing referred to offered in evidence and marked Chinmoeck Exhibit A.)

A. I think about April or May, 1879. I had heard previous to that, that a transmitter, called the Blake transmitter, or Microphone was in use, but I had no description of it; but in May I procured an instrument from Mr. Bergmann. This is the first I ever saw.

By Mr. J. J. SPOONER:

169 x Q. Where was the model for application of June 2, 1879, case 178, made?

A. The parts of the instrument brought me by Mr. Bergmann was used as a model.

170 x Q. Who is Mr. Bergmann?

A. A manufacturer of telegraph instruments in New York.

171 x Q. The instrument Mr. Bergmann brought you was one made by the Bell Telephone Co. marked as their property, was it not?

A. I believe it was. It was marked the Blake Transmitter. I am not certain it was marked as the property of the Bell Telephone Co. I asked Mr.

Bergmann to procure me an instrument which he did as above recited. 137

172 x Q. How many of these springs marked Exhibit 43-11 were there on the instrument on which these 3 were used?

A. I think there was five.

173 x Q. Were the other two just like these three?

A. Yes, sir.

174 x Q. Were the other two arranged in the instrument just as these three were?

A. Yes, sir.

175 x Q. How soon after you got the Blake transmitter from Mr. Bergmann was your application 138

178 prepared?

A. I think within a month or so.

176 x Q. Was it prepared by you or by Mr. Serrell?

A. I believe the rough draft was drawn up by me and the application was drawn up by Mr. Serrell.

177 x Q. Who made the drawing?

A. I think the drawings for the application were 139

made by Mr. Serrell's draftsman.

178 x Q. What did he have to make them by, sketches or model?

A. Both, sketches and model.

179 x Q. Chinmoeck Exhibit A referred to in your

138 answer is the drawing of Mr. Blake's interfering application, is it not?

A. Yes, sir. It appears to be.

Adjusted to Friday, April 16, 1880, at 10-12 140

A. M.

May 1879
house of
Blake

June 2, 79
app. 178 -

141

LABORATORY OF T. A. EDISON,

MENLO PARK, NEW JERSEY,
Friday, April 16th, 1880.

Met pursuant to adjournment.

Counsel present as before.

Continuation of examination of T. A. Edison.

142

Re-directed by L. W. SKRELL, Esq.

180 Re-D Q. In answer to x Interrogatories 72-101 and 110, you speak of experimental instrument put in the scrap, what was this scrap and what was done with it?

A. This scrap was composed of parts of instruments which were used to make other instruments with.

143

181 Re-D Q. Tell us where this scrap was kept, and whether or not you ever sold or disposed of portions of such scrap?

A. It was kept in boxes, in drawers, and on tables; none of this scrap was sold as the parts composing the scrap were useful in making up combinations for other instruments.

182 Re-D Q. In one of your answers you refer to a scrap heap; what did you mean by that, or what was this which you call a scrap heap?

144

A. What I mean by scrap heap, is mixed parts of instruments in different places around the laboratory "scrap heap" is the usual term used when a combination is broke up and parts thrown in among other parts.

183 Re-D Q. Do you in any portion of your testimony when speaking of scrap or scrap heap refer to material usually known as scrap in manufacturing establishments, consisting of old useless material intended to be sold as old metal or melted over?

145

A. No. My scrap is composed of made parts and the class of scrap is very much different.

184 Re-D Q. In answer to interrogatory 110, you speak of some telephones that were not "commercially useful" what do you mean by that expression?

A. I mean that with my experience and judgment at the time that they would not work in the hands of the public satisfactorily to any individual or company introducing them.

146

185 Re-D Q. What difference, if any, was there in the circumstances under which you used telephones in your laboratory and the circumstances under which telephones would be used by the public; and what, if anything, would render a telephone instrument successful when used in your laboratory and not adapted to use commercially?

A. In the first place there was no induction to speak of on the lines upon which the experiments were conducted at the laboratory; in the second place there was more quiet at the laboratory than in cities, where the majority of telephones would be used. In the third place, instruments in the hands of experts might be made to work satisfactorily in the hands of such experts and yet be a failure, especially where a great number were in use. Experts sometimes unconsciously remedy defects which the public would not do. If an instrument requires fine adjustment to obtain satisfactory results, or if it changes adjustment, often, although it may work splendidly otherwise, would perhaps be a commercial failure, rendering the necessity of the employment of a number of experts to keep the instruments in order, which reduces the profit derived from the rental of such instruments.

147

186 Re-D Q. When and under what circumstances did you make up your mind as to what was necessary in a telephone in order to render the same a commercial success; or in other words, when did you conclude that telephones would have to be made

148

149 so as to avoid the difficulties of which you have spoken in order to render the same a commercial success?

A. I came to that conclusion in 1875. My experience with the Gold and Stock Telegraph Co. and the Western Union Telegraph Co. taught me that if an instrument worked a month or even two months without getting out of order in a laboratory, that that was no criterion. That if many hundreds of such instruments were made in manufacturing and introduced to the public that they would be satisfactory. Manufacturers do not, as a general thing, make every instrument alike, and without the instrument has considerable working margin to allow for this fact and also to allow for the fact that the instruments are handled and used in different ways by different persons composing the public, that it might not be a commercial success, as the expenses incurred in keeping the apparatus in order might equal the receipts derived from the rental of them.

151 187 Re-D, Q. Did you or not confer with any person from time to time relative to your telephone instruments in order to obtain their opinion of such instruments and of their opinion relative to such instruments being commercially successful?

(Objected to as irrelevant unless confined to instruments embodying the matter in controversy.)

152 A. Of course I conferred with my assistants, Batchelor and Adams, and also with Mr. Orton, the President of the Western Union Telegraph Co.

188 Re-D, Q. State what time the conferences with Mr. Orton commenced and whether they related to either of the instruments shown on the Exhibits produced in this case?

A. They commenced in 1875. I had a conference with him regarding the instrument shown in the Exhibit 188-12.

189 Re-D, Q. Were you or not satisfied with the accuracy of the commercial when using either of the instruments shown by either of the exhibits that you have produced?

A. That is a very hard question for me to answer. I am even now not satisfied with the articulation and volume of sound in *any* telephone.

190 Re-D, Q. After conference with Mr. Orton relative to the instrument Ex. 188-12 what conclusion did you arrive at relative to the commercial availability of the same, using that expression in the sense in which you have explained it?

A. I arrived at the conclusion that the instrument shown in 188-12 might be made commercially successful on certain lines, but not on the lines such as this instrument was tested on at the Gold and Stock Telegraph Company office in the Western Union Building. It was not loud enough under the conditions there. Mr. Orton also decided that it must be made louder and that he did not think it was clear. My impression is that Messrs. Batchelor and Adams decided that it was clear at the laboratory.

191 Re-D, Q. Please tell us what the conditions were that interfered with the instrument when tested on the Gold and Stock Co.'s wires?

A. The induction from the Stock Printing Telegraph circuits was so strong that it was painful to hold the receiver to the ear.

192 Re-D, Q. Tell us whether or not those conditions of use would still interfere with the clearness of telephone instruments as now constructed in the most improved form if applied on the Gold and Stock wires?

A. Yes, sir; but nowadays the practice is as far as possible to isolate telephone wires from wires not worked telephonically.

193 Re-D, Q. If the instrument represented on 188-12 had been tested on wires under circumstances corresponding to the telephone system as now made

157 use of, would or would not said instrument in your opinion have been satisfactory?

A. The question of satisfaction is a relative one. I have seen telephones working in New York, which the parties said worked good that I could not distinguish anything on; hence, in the present state of the art I should say that the instrument shown in 188-12, if worked under conditions now existing, might be satisfactory, but they would not be satisfactory to me.

158 194 Re-D. Q. Did you adopt any measures to test whether or not any of your telephone instruments made before November, 1877, was liable to become out of adjustment or injured by rough handling, such as such instruments might be subjected to either accidentally or purposely when in the hands of the public?

A. Yes, sir; we used to drop them on the floor, hammer them, and throw them out in the field.

159 195 Re-D. Q. Did you and your assistant have any difficulty in arriving at satisfactory conclusions, relatively to the clearness or loudness of either of the telephone instruments made before November, 1877, and if so, what was that difficulty, or how did you ascertain whence it arose?

A. Yes, sir; we had frequent quarrels and disputes regarding the loudness of different telephones, but I relied on their judgment about articulation because I used to read hard sentences to them through the telephone. For a long time disputes arose as to the loudness of a certain instrument, compared to its loudness at a different time. I subsequently discovered the cause of these disputes, for instance at night we would put up a telephone in connection with the circuit and notice the volume of sound, afterward perhaps a day, we would test it again, when we would differ as to the loudness. They generally maintaining either that it was either louder, or not so loud. After a while I found that in the day time they always maintained that the thing was

lower and at nights louder, whereas I could not discover much change, if any, and this was caused by my partial deafness, as a thousand and one extraneous sounds which they could hear in the day time, and which were inaudible to me either day or night, hence if the night was very quiet and they fixed in their minds the impression of a particular loudness of talking, this the volume of sound to them, was materially decreased if the instrument happened to be tested in the day time, as the sensibility of persons with acute hearing is reduced by other sounds, whereas no such effect is apparent to me under ordinary conditions.

(Granted for Edison offers in evidence a copy of the Journal of the Telegraph, dated April 16, 1876, and makes page 114 article, Edison Carbon Telephone an Exhibit in this case.)

By Mr. J. J. STORROW.

160 196 x Q. Look at your 188th answer. You don't mean to say that you had any experience with the Gold and Stock or Western Union on speaking telephones in 1875, do you.

A. I had experience in the practical introduction of printing telegraphs to the public, also quadruplex telegraphs in the hands of operators, electric pens and acoustic telegraphs in the hands of the public.

161 197 x Q. That is the experience you referred to.

A. Yes.

198 x Q. Look at your 188th answer. You don't mean to say that you had any conference with Mr. Ottor in 1875, about the instrument shown in Exhibit 188-12?

A. No, not in that year.

THOMAS A. EDISON.

*Journal of
Telegraph
Apr. 16, 1876.*

125 MEXICO PARK, NEW JERSEY, }
Thursday, April 15, 1880, }

CHARLES BATCHELOR, being duly sworn, deposes and says, in answer to interrogatories proposed by J. J. Storow, Esq., in behalf of counsel for Mr. Edison—he having to be absent—as follows:

1 Q. State your name, age, residence and occupation?

100 A. My name is Charles Batchelor, age 34, residence Menlo Park, occupation assistant to Thomas A. Edison.

2 Q. What has been your residence and occupation since the beginning of 1877?

A. I have been assistant to Thomas A. Edison.

3 Q. State whether or not during that time, and as assistant, you have made apparatus and experiments for him relating to electric speaking telephones?

A. I have.

107 4 Q. What proportion of your time during the years 1877, 1878 and 1879 were spent in making such apparatus?

A. All my time during the night and most part of the day work.

5 Q. Look at Edison's Exhibit 42-11; state whether it bears your signature?

A. Yes, sir; it does.

6 Q. When and by whom was the drawing made, and when did you sign it?

108 A. The drawing was made by Mr. Edison on or before April the first and signed by me on that date, or within a day of that date.

7 Q. Did you make the apparatus shown in that sketch on the top of that paper, which Mr. Edison testified, is more fully shown on figure 260, page 634, of the 2d edition of Mr. Prescott's book on the speaking telephone?

A. In conjunction with James Adams, now deceased, made that apparatus.

8 Q. Did you use it after it was constructed, and how?

A. I did. I used it with James Adams and Thos. A. Edison, as a transmitter for a telephone circuit.

9 Q. What did you transmit with it, and with what success?

A. We transmitted ordinary speech perfectly.

10 Q. Did Mr. Edison have any difficulty or any physical trouble which made experimenting with him in speaking telephones difficult; if so, what?

A. Yes; it was very difficult to experiment with Edison owing to his deafness; perfect talking, if very low, was no talking at all to him, because he could not hear it.

11 Q. Of what material were the different parts of the instrument described in your 7th answer constructed?

A. The springs were made of steel, about 2 inches long and 1-50 of an inch thick, and about 3-8 of an inch long; the bottom end of these springs was fastened to brass, about 5-16 of an inch square and 3-4 of an inch long, with an elongated hole in them, so that the spring could be screwed to an insulating bar and adjusted to position. The other end of the spring carried a brass sleeve projecting about 1-8 of an inch from each side, in which was pressed tightly a hard pressed bottom of plumbago. This was afterwards filed down on each side so as to project about 1-16 from each end of the sleeve. There were five of these springs in the instrument. The diaphragm of the instrument was about 3 and 1-2 inches, and the speaking case was turned from wood. The diaphragm being held to the case by a brass ring. This whole apparatus was placed on a base with the springs upright. The electric circuit passed out at the bottom of the spring nearest the diaphragm, thence through all the plumbago and passed out at the bottom of the farthest spring from the diaphragm. The springs themselves were made by Adams.

12 Q. What has become of that instrument?

173 A. Most of the parts of that instrument have been used in other experiments, only a few of them being able to be found at present. After an experiment is tried in the laboratory it is usual with us to use as much of the instrument used in making the next experiment.

13 Q. The drawing is dated April 1, 1877; how soon after that date did you make and use this apparatus?

174 A. It was made within two or three days of that date, and I believe was made before the next morning after that date.

14 Q. At the time you made this apparatus what was your belief as to the importance of arranging a battery transmitter of an electric speaking telephone so that its electrodes would or would not break contact when the instrument was talked in it?

175 A. At that time it was my belief that no instrument that broke the electric circuit would ever transmit speech perfectly. Mr. Edison's idea in this particular case I understood to be not to break contact under any consideration, as from previous experiments we had found it a bad thing.

15 Q. Upon what did you rely to prevent these five carbons from breaking contact at the four places of contact between them and through which the current had to pass when they were agitated by the vibrations of the diaphragm?

176 A. We relied upon the springs holding the plumbago pieces. These would certainly have separated by their momentum, which we wanted to use but to keep under control. That, I believe, was Edison's idea when he gave us the drawing.

16 Q. Look at Edison's Ex. 106-11, marked May 29, 1877. State whether it bears your signature, and if so, say when and by whom the drawing was made and when you signed it, and whether the drawing was there when you signed it?

A. The Exhibit was signed by me on or about May

20, and the drawing was on the paper when I signed it. The drawing was made by Mr. Edison.

17 Q. Did you construct an apparatus substantially like that drawing, and when, and if so, what use did you make of it after you had constructed it, and with what success?

A. I did, slightly different from the drawing, but practically the same. As an instrument the instrument did not give any satisfaction at the time, the talking not being good, even to myself.

18 Q. What did you then consider to be the cause of the bad result with it?

A. I have not in my mind just at present why this did not work, and think that it was tried a very short time.

19 Q. What were the electrodes made of?

A. Platinum.

20 Q. Look at the drawing now shown you marked Edison Ex. 112-11, dated May 31, 1877. State whether it bears your signature when you signed it, whether the drawing and date were on the paper when you signed it, and who made the drawing?

179 A. Mr. Edison made the drawing, and my name was put on by me on or about the date marked on the paper. The drawing and date were on them when I signed it.

21 Q. Did you at any time construct the instrument as there drawn, if so, when, and of what material were the parts made?

180 A. I, with Adams, constructed the instruments substantially as here shown on or about the date shown. It consisted of a cup of brass in which was held a solid cylinder of plumbago, the cup or brass being fastened to a spring at first of wood, on this spring a piece of hard rubber insulating material, with a platinum spring fastened to it, the platinum pressing against the face of the plumbago. This spring of wood was placed in such a position that the platinum spring rested against, and put an initial pressure on a diaphragm, which was secured to

161 a speaking tube, the diaphragm in this case being about 3 1/2 inches, but I believe we tried it with larger diaphragms about that time, afterwards. The electric circuit passed in at the platinum spring through the plumbago button or cylinder, and out from the brass cup.

22 Q. I notice in that drawing some kind of a block fastened to the diaphragm, what was that for, and did you put that in the instrument that you made?

183 A. I do not believe the block was on the diaphragm, but I think Mr. Edison's idea in putting it there in the drawing was that it would work out for enough to prevent any other parts of the instrument from touching the diaphragm or case.

23 Q. Did you make any use of the instrument constructed as you have described, and if so, what use, and with what results?

A. Yes, we made use of the instrument as a transmitter of speech, with good results.

183 24 Q. Did you afterwards make any change in that instrument, and if so, what was the first change you made?

184 A. The first change that we made in the instrument was to make weights for the end of the lever, to alter its period of vibration. I believe the first thing like a fault in this instrument was its peculiar sensibility to the explosive consonants, and we made a number of weights that we could slip into a screw stud and weight the end of the lever to prevent this. The stud was placed on the opposite side of the spring from the plumbago cylinder, and directly opposite, and was about 2 1/2 inches long; it was provided with a nut to keep the weights from coming off.

25 Q. What results did you find from this change, the addition of this weight?

A. I do not believe that we noticed any change, that is for better talking. Myself and Adams being able to receive any conversation sent by means of this transmitter before the change.

26 Q. What effect did this change have, if any, upon the trouble which you had noticed when the explosive consonants were uttered into this transmitter?

A. I do not remember that it modified them, they were not so bad but that we could get the talking very plain.

27 Q. Please look at the paper now shown you marked Edison's Exhibit 2-12, dated July 5, 1877, state whether it bears your signature, whether the drawings were on it before you signed it, by whom the drawing was made and when you signed it?

A. The drawings were made by Edison I believe, and it was signed by me on or about the day it is dated. The drawings were all on them, I believe.

28 Q. Please answer the same question as to Exhibit 6-12, dated July 7, 1877?

A. The drawings I believe were made by Edison, were on the paper when I signed it, and was signed by me about the date when it was marked.

29 Q. Please answer the same question as to Exhibit 105-12 dated Sept. 21, 1877?

A. I believe the drawings were made by Edison, and signed by me about the date there marked on the paper, and I believe all the drawings were on the paper at that time.

30 Q. Please answer the same question as to Exhibit 188-12, dated Sep. 30, 1877?

A. I believe the drawings were made by Mr. Edison, and my signature was put on there about Sept. 30, 1877. I believe all the drawings were on there at that time.

31 Q. I notice that several of these drawings bear the signature of Mr. Adams, are they his signatures, and is he the Mr. Adams spoken of in this deposition?

A. Yes, sir.

31 Q. I call your attention to the middle figure on sheet, of July 5, and the middle figure on sheet July 7, and various figures on sheet of Sept. 21, and

189 sheet of Sept. 20, did you ever make any instrument substantially in accordance with those figures, and if you made more than one, please describe them in the order in which you made them?

A. The instrument marked Ex. 2-12, I believe was never made in the way shown on this Exhibit, but I remember Mr. Adams fastening by threads a plumbago button to the centre of a diaphragm as shown on Ex. 0-12. This instrument, I believe, he made in place of the one shown on Ex. 2-12, as being easier to make. The description of the instrument is as follows: a small cylinder of plumbago is held to the diaphragm by a small thin platinum plate which is held there by threads; I believe 3 or 4 threads were used in place of the two shown in the drawing. The object of the plate on the end of the cylinder was for the wire leading to the end of the cylinder to make contact with. I believe I listened to the talking in that instrument and also talked in it. The size of the diaphragm in that instrument was about 2.3-4 inches in the clear.

Adjoined to Friday, April 16th, 1880, at 10 1-2 o'clock, A. M.

S. L. GRIFFIN,
Notary.

FRIDAY, April 16th, 1880.

192 Met pursuant to adjournment.

Counsel present as before.

Answer continued.

I should say in regard to that instrument, although the instrument marked on 2-12 was never made, and that the instrument on 0-12 was made, I mean that the plumbago cylinder held to the dia-

phragm by threads as shown in 0-12 was used in connection with a speaking tube standing upright as in Ex. 2-12. The electric circuit passed in at the diaphragm through the plumbago cylinder or first entered the instrument at the small platinum plate on the outside end of the plumbago cylinder, thence through the plumbago cylinder to the diaphragm, from which it passed out. The instrument shown in Ex. 105-12 (Sept. 21, 1877), marked 1 and 4, I do not think were made. The instrument No. 2, I believe was made by Adams and it worked well. The instrument No. 3 was also made by Adams, I believe from the parts of the instrument No. 2.

33 Q. Were the drawings No. 1 and No. 4 on that sheet substantially different from or substantially the same as the drawing on 0-12 and 2-12, which you have just described, so far as relates to the principle and mode of operation of the apparatus?

A. Yes. They were specially designed for the special purpose of getting an increase and decrease of contract by momentum and inertia.

34 Q. In No. 2 and No. 3 of sheet 105-12 what if anything was relied on for inertia to hold the carbon button against the rapid vibrations of the diaphragm?

A. A body of air was relied on in addition to the weight of the electrode.

35 Q. In No. 2 and 3 of that sheet what is the curved line the two ends of which rest on or near the diaphragm?

A. The curved lines spoken of represent threads or strings which were fastened, I believe in No. 2 to the ring holding the diaphragm and in No. 3 to small hooks fastened to the face of the diaphragm a suitable distance from its centre.

36 Q. Please state whether you ever made any instruments substantially in accordance with the figure of sheet 188-12, dated Sept. 20, 1877?

A. Yes, we did. The instrument that was made about that time was substantially the same as shown

197 in figure 1. It consisted of a hard rubber sleeve fastened to the diaphragm on the outside of which was a screw thread. A hard rubber cap, with screw thread inside fitted into this. In the inside of the cap on the diaphragm and next to it, was placed a plumbago coated pad of silk; next to which was placed a circular weight and between the weight and the end of the cap was placed a spiral spring. The circuit was connected to the diaphragm, from thence through the plumbago, thence through the weight and spring to which was soldered the wire leading from the instrument. This instrument I believe we tried with hard carbons, with plumbago and I believe soft lamp black pressed.

37 Q. In using the different instruments described in your 31 to 30 answers inclusive, in what position did you hold the diaphragm,—horizontal or perpendicular?

199 A. The instrument that was made as a combination of 6-12 and 2-12 had its diaphragm in a horizontal position, the instruments Nos. 2 and 3 on Exhibit 105-12 and also No. 1, on Exhibit 188-12 was in a vertical position.

38 Q. Please state what results you obtained as to the transmission of articulate speech by the instruments referred to in your last answer?

A. In all these instruments good talking was obtained.

39 Q. State whether or not the instruments which you made and tried substantially in accordance with the sheet 188-12, is or is not described with substantial accuracy in the passage from Mr. Edison's English patent 5,060, quoted in his 42nd answer?

A. Yes, sir; it is.

40 Q. How soon after the dates of these respective papers were the instruments referred to in your 38th answer made and tried?

A. Within a few days of the date on the paper. I generally received them immediately after my own

signature was on, and Adams and myself went to 201 work at them immediately.

41 Q. In your 33d answer you say that these forms of instrument were specially designed for the special purpose of getting an increase or decrease of contact by momentum or inertia, state whether or not before July 5, 1877, you had constructed in accordance with Mr. Edison's instruction any apparatus in which use was made by inertia or momentum of the electrode not attached to the diaphragm for the purpose of varying contact between it, and the electrode 202 attached to the diaphragm, when the diaphragm vibrated?

A. Yes, sir; such an instrument is shown in one of the Exhibits here to-day, and that instrument was described by me yesterday. It is shown in Exhibit 112-11, May 21, 1877. In this instrument a very strong spring was used to prevent the breaking by its inertia the too sudden change of contact. After this instrument was tried a number of weights were added to the end of the spring to increase its inertia.

42 Q. If any parts of that instrument are here present as exhibits, please identify them, if you can?

A. There are. The cup and plumbago cylinder marked "Edison's Exhibit Cup and Carbon, 112-11," and also some of the weights, marked "Edison's Exhibit Weights, 112-11."

43 Q. Can you tell me how many more weights there were used on that instrument, beside the six produced as exhibits?

A. I cannot at present remember how many were made, but I believe there were a few more used than what we have here.

44 Q. Please state the weight of the exhibits referred to in your 42nd answer?

A. The weights marked "Edison's Exhibit's Weights, 112-11," weigh about one hundred and eighteen grammes, and the cup and carbon about 50 grammes.

45 Q. Do you know when instruments having

205 diaphragm and electrodes like "Edison's Exhibit Mica Diaphragm," were first made for commercial purposes?

A. I believe a number of these instruments were made in Edison's Laboratory about June, 1879. They were made for the "Edison Telephone Company, Limited, of London."

46 Q. In trying these telephones as you have described, where did you place the transmitter, and where did you place the receiver?

206 A. The transmitter was generally placed in the early part of our experiments in the front part of the bottom floor of the Laboratory Building, and the receiver in the back part of the top floor. Afterwards this was reversed. The distance apart is about one hundred feet.

47 Q. Did you ever place them any further apart than that?

207 A. Yes. Occasionally we took the transmitter to either Adam's or my own house, and sometimes to the depot, where private lines run from the Laboratory.

48 Q. You have said that these different transmitters that you have described, transmitted articulate speech successfully. Why did you not go on and make more of them, and put them to public use?

(Objected to as necessarily calling for hearsay.)

208 A. I believe these instruments did not come up to what Mr. Edison had made in his mind as a standard of a commercially successful telephone. Some of them, although successful telephones. Some of them were working with them, not being thought good enough by Mr. Edison. If a telephone, for instance, was not a loud telephone, it was practically useless to him on account of his deafness.

49 Q. Were there any telephones at that time, in the summer and autumn of 1877, in public use with

which telephones constructed by Mr. Edison would have to go into commercial competition?

A. I believe there were.

50 Q. What other telephones were there?

A. I only know of the Bell telephone.

By Mr. L. W. SERRELL:

51 Q. Did Mr. Edison at any time have any telephone instrument made by any other party so as to institute a comparison between the same and his own?

A. I do not remember at any time on, or previous to these dates, of his having any telephone supplied to him of any one's make until long after the earliest date of these exhibits. I don't know of any telephone of that kind that was supplied to Mr. Edison.

52 Q. Do you know who made the instrument shown on Exhibit 188-12, No. 1?

A. I believe some parts of it were made by myself.

53 Q. Do you know whether any one else was working in Mr. Edison's shop at that time besides Mr. Adams and yourself?

A. Yes, sir; John Kreusi.

54 Q. Do you know whether any changes were made in the instrument represented upon Exhibit 188-12, and if yes, what?

A. Yes, sir; numerous changes were made. The spring being changed a number of times for lighter or heavier springs. I believe Mr. Kreusi made these springs, and they were afterwards put in the cups and tried.

55 Q. What object was there in making these changes?

A. The object was to alter the inertia of the weight in the cup.

56 Q. And were these instruments all tested with the different springs you have stated, and if so with what result?

213 A. I believe they were; they all worked. They were all good speaking telephones, but I do not remember that there was any remarkable improvement in the changes made in those springs.

57 Q. What period of time was occupied in making these changes and during what months were they made?

A. They were made during the month of October, 1877, and I believe occupied no more than two weeks.

214 58 Q. Referring to Exhibit 112-11 please state in what manner the parts were adjusted, if at all, so as to adapt them to use?

A. The only adjustment that I remember on this machine was on the large spring, which could be made to press on the diaphragm by moving the post to which it was attached. The end of the spring opposite to the end holding the plumbago was attached to the post. The diaphragm was brought in connection with the small platinum spring which rested against the plumbago cylinder, thus the adjustment of this large spring put more or less pressure on the diaphragm.

215 59 Q. And when the instrument was in use did the diaphragm and the platinum spring separate by the movement, or were they intended to separate by the movement of the diaphragm when spoken against.

(Objected to as leading by counsel for Mr. Chincock.)

216 A. I believe it was not Mr. Edison's intention to have them separate at all.

60 Q. To what were the conducting wires connected in this Exhibit 112-11?

A. One of them was connected to the small platinum spring and the other to the brass cup holding the plumbago. When I speak of the platinum spring

I mean a small brass spring that was coated with platinum for contact with the plumbago. 217

61 Q. I notice in the plumbago Exhibit cup and carbon 112-11 a groove across the face of the plumbago; do you know what has produced the same?

A. I cannot remember just now the reason why that groove was put in there, or the instrument for which it was made. It was not there when we tried the experiment, as shown substantially in Exhibit 112-11.

62 Q. About how much of the surface of the plumbago was covered by the platinum-faced spring of which you have spoken? 218

A. I cannot say exactly, but I believe almost the whole surface. The edges, however, of the plumbago were beveled a little.

63 Q. Please look at the Exhibits 42-11, 46-11, 112-11, 2-12, 6-12, 165-12, 188-12 and 17-13, and state whether or not you can discover on either one any changes other than the marks made for the purpose of this interference, from what they were when you signed your name upon them? 219

A. I believe there has been nothing added, either in diagram or writing, except those things mentioned in the question since I signed my name upon them.

64 Q. In answer to interrogatory 51 you speak of "any telephone of the kind," please explain what you mean?

A. I refer there to the instrument generally known as the Bell Telephone.

65 Q. Do you know whether or not Mr. Edison made for the purposes of experimenting or test, before October, 1877, any instrument corresponding to that which you say was generally known as the Bell Telephone? 220

(Objected to as immaterial and irrelevant by counsel for Mr. Chincock.)

A. I know that Mr. Edison had two Magneto

221 Telephones made in his laboratory, but I cannot fix the date of their make. I think it was previous to October, 1877.

66 Q. Do you know whether or not these Magneto Telephones could be heard by Mr. Edison, or whether there were any experiments made in which their capacity was tested?

(Objected to as counsel for Mr. Chinnock, as immaterial and irrelevant, because no date was fixed by the witness for the making of these telephones and no testing has been introduced relative to the character of these instruments so as to show what their capacity were.)

A. I do not believe that Mr. Edison ever heard anything satisfactorily over a magneto telephone until a carbon transmitter was used at the transmitting end.

223 (Objected to as mere opinion.)

67 Q. In seeking to make a telephone instrument that was adapted to general use, did you ever adopt any measures to ascertain whether or not any of the instruments made for Mr. Edison were liable to injury in use, or were liable to be put out of adjustment?

A. Yes, sir. An instrument that could not be handled by any ordinary person, and that would get easily out of adjustment however good the talking was from it, was not considered by Mr. Edison to be of great commercial value. Such an instrument as I mention was made from drawings on Exhibit 6-12, and Ex. 105-12, although giving perfect talking was not considered by him to be of such a standard that was requisite to go in uneducated hands. I have known Mr. Edison to frequently drop an instrument on the floor, in order to see if it would loose its ad-

justment, if so, he would endeavor to devise some further means to prevent this.

68 Q. What has been the result as far as you know of Mr. Edison's prolonged efforts to produce telephone instruments of commercial value, and that were not likely to get out of order when in use. State whether or not any of Mr. Edison's instruments have gone into public use?

(Objected to as immaterial and irrelevant unless not involving the matter in controversy.)

A. The result, as far as I know, of Mr. Edison's efforts is the production of the loudest speaking telephone in existence. These telephones have been used largely.

Cross-examination by E. H. Brown, Esq., counsel for Mr. Chinnock.

69 x Q. You say that all your time during the night and most part of the day was devoted to experiments with speaking telephones, you mean in that connection speaking telegraphs generally, and not only a speaking telegraph shown in the Exhibits in this case, do you not?

A. Yes. Speaking telegraphs generally.

70 x Q. Referring to the measurement of springs given in your 11th answer, how did you determine that said springs were only 1-50 of an inch thick?

A. I did not measure the thickness of the spring, but judged so from the looks of it.

71 x Q. Were those springs tempered?

A. I do not know, being steel they must have a certain amount of temper in them, but I do not know whether they were specially tempered for the purpose.

72 x Q. Did you see the drawing on the Exhibit 106-11 referred to in your 16th answer made by Mr. Edison?

229 A. I cannot be certain about that. I was generally present when the drawings were made.

73 x Q. Which, if any of the drawings shown in the Exhibits are you certain that you saw him make?

A. The only one that I distinctly remember to have seen him make was the one marked Exhibit 17-13. I cannot speak positively for the rest.

74 x Q. You were present at the taking of, and heard the testimony of Mr. Edison in this case, is that so?

230 A. I was present, and believe I heard almost everything.

75 x Q. Do you know who found the parts of instruments which are filed in this case as exhibits, and where they were found?

A. The exhibit marked Exhibit Cup and Carbon, 112-11, was found. I cannot be sure by whom and brought to me about three months ago, in one of the scrap heaps of the laboratory, since then I have had it on one of my shelves in the upper room in the laboratory. The spring marked Edison's Exhibit Spring, 42-11, two of these were found during the summer of 1878 in a scrap heap, the other spring was found in the scrap heap by me two days ago, this scrap heap was formed by dumping out all the old drawers and boxes that contained any scrap about the place. The weights marked Exhibit Weights, 112-11, were also found by me about the same time in dumping out a drawer into the said scrap heap. The diaphragm marked Exhibit Diaphragm, 17-13, was found by Martin Force, in one of the instrument cases in the laboratory on a top shelf

232 that we generally throw any of such things into, if we think they will be valuable. This diaphragm, I believe, was put there by Mr. Kruetz, as I believe it had a tag on it, with his name on. The Exhibit Edison's Diaphragm, 165-12, was also found in the scrap heap two days ago by myself. I do not know who found the spring marked Edison's Exhibit

Spring, March, 1877. I believe it was found in our scrap heap.

76 x Q. Were the two springs which were found in the summer of 1878 found at that time, with reference to the controversy with Mr. Edison and Mr. Hughes, do you know?

A. They were found for the purpose of showing that such an instrument had previously been made.

77 x Q. Do you know whether or not they were found with reference to that controversy?

A. Yes, they were.

78 x Q. How soon was the change referred to in your 24th answer made, after the making of the instrument therein referred to?

A. I believe it was made within a day after the instrument was tried.

79 x Q. Are you sure that instrument No. 2, in Exhibit, 165-12, was ever made.

A. Yes, sir.

80 x Q. Do you know the size of the diaphragm that was used in the instrument, exhibit 188-12?

A. Yes, sir; The size of the diaphragm was about 2 3/4 inches in the center. The size of the cup that was fastened to the diaphragm I cannot remember, although I made it, my impression is that the inside measurement was between 3-8 and 1-2 inch.

81 x Q. Which produced the best results, the stouter or lighter springs used in that instrument?

A. That depended entirely, as far as I remember, on what degree of loudness the instrument was talked into; I believe a stronger spring gave better talking—more suitable talking for Mr. Edison—whilst with ordinary talking in the instrument some of the weaker springs were equally good to me—the stronger spring generally allowing of greater strength of talking. The difference in the clearness of the articulation depended entirely on the person listening; what would be perfectly clear to me was sometimes too low for Edison, whilst what he considered

297 sometimes as good talking. I did not think as good as the lower.

82 x Q. Referring to Exhibit 112-11, please state to what the large spring was secured and how it was secured?

A. I do not remember exactly which particular post we used for that spring; we had a number of different sizes that we had used for previous experiments, but it was made fast by screw to the post. It was secured rigidly to the post.

298 83 x Q. What were the telephones referred to in your 49th answer?

A. I referred to the telephone generally known as Prof. Bell's.

84 x Q. How many more weights were there like the weights Kx, 112-11?

A. I cannot tell how many were used, but believe there were some slightly thicker than the largest there. They were not all thicker. I believe we have here the greater part of the ones that were used. I 299 should judge that we had not more than double the total weight of these here.

CHAS. BATCHELOR.

LABORATORY OF T. A. EDISON,
MEXLO PARK, NEW JERSEY,
Friday, April 16th, 1889.)

300 JOHN KRUESL, being duly sworn, in answer to interrogations propounded to him by L. W. Serrell, counsel for T. A. Edison, deposes as follows:

1 Q. Please state name, age, residence and occupation?

A. My name is John Kruesl; my age is 37 years; residence, Menlo Park; occupation, foreman of mechanical department for Thomas A. Edison.

2 Q. Please look at the sketches Edison's Exhibit 188-12, and state whether or not you ever saw any

parts corresponding to such sketches, and if so, what were they?

A. Yes, sir; I have seen parts which were made for a telephone. These were made, a rubber cylinder with a screw thread on the outside of it, which was for a cap that went over the outside for an adjustment. The cylinder that had the screw thread on the outside was fastened to the diaphragm of a telephone transmitter. Inside of this cylinder there were several things used, as far as I know; there was a fluff of silk saturated with carbon, and a round piece of metal and the spiral spring soldered to it. One wire was connected to this metal piece. I think this was used with a diaphragm that had a piece of platinum foil between the carbon and the diaphragm, and the other wire was connected with this.

3 Q. This round piece of metal that you speak of as inside the rubber cylinder, was this loose or fast?

A. It was loose enough in the cylinder so as to play.

4 Q. Did you test this instrument, or know of its being tested or tried?

A. I have not tested this, and do not know the result of the test.

5 Q. Do you know when it was that you made the parts of the telephone instrument of which you have spoken?

A. I do not know the exact date, but I think it was in the Fall of 1887, about September.

6 Q. Did any person work with you, or make any of the parts of this telephone instrument?

A. Yes, I believe Mr. Batchelor did.

7 Q. Do you remember whether or not there was more than one of the telephone instruments made with the parts shown on Exhibit 188-12, or whether any parts were altered, or other parts made for the same?

A. As far as I remember there was only one cylinder made with one cap, but I think for that one were many springs made of different tensions.

240 8 Q. About how long a time was occupied in making these parts, and between commencing to make this telephone and the time the last spring was made?

A. I do not remember that.

9 Q. Do you know whether or not Mr. Edison was occupied much of his time in 1877 making telephone instruments and devices?

A. Yes, sir, he was.

JOHN KRUESI.

240

LABORATORY OF T. A. EDISON,
MENLO PARK, NEW JERSEY,
Friday, April 16th, 1880.

WILLIAM CARMAN, being duly sworn, deposes and says in answer to interrogatories propounded to him by L. W. Serrell, counsel for Thos. A. Edison, Esq., as follows:

247 1 Q. Please state name, residence and occupation?

A. My name is William Carman; my age is 31 years; residence Menlo Park, New Jersey; occupation bookkeeper for Thomas A. Edison.

2 Q. Please look at Exhibits 42-11, 106-11, 112-11, 2-12, 6-12, 105-12, 188-12, and 17-13, and state whether you ever saw the same before?

A. I have in the early part of 1878.

3 Q. Where were they at that time, and what was their condition?

248 A. They were in the laboratory of Mr. Edison, bound in book form, in covers similar to "Exhibit Laboratory Notes."

4 Q. Was anything done to said books, if so, when?

A. About April, 1878, the drawings were taken from those books by me in order to have tracings made of the same.

5 Q. Did you make tracings of either of the Exhibits to which your attention has been called?

A. Yes, I made tracings of all of these Exhibit

drawings to which my attention has been called. 249 These tracings were made by me between April, 1878 and October, 1878.

6 Q. Please examine those Exhibit drawings to which your attention has been called, and state whether or not any changes or additions have been made to the same to the best of your knowledge or belief, except the marks and numbers that have been added to the same for the purposes of this interference?

A. Nothing but the numbers of the pages in the upper left hand corners of Exhibits 42-11, 106-11, 188-12, 105-12. 250

7 Q. I notice upon some of said exhibits, particularly 42-11, small dots of ink upon some of the pencil lines, do you know how those came there?

A. I do. Those were caused by the ink's flowing through the pores of the tracing cloth, which tracing cloth was very poor.

8 Q. What knowledge have you had of these exhibits since April, 1878; where have they been or in whose custody?

A. They were in the laboratory of T. A. Edison for about eight or nine months, and were then taken to New York, to the best of my knowledge to the office of L. W. Serrell, and I did not see them again until about six weeks ago, when they were brought back and have been in my possession since.

9 Q. Have you compared the exhibit drawings examined with the tracings made by you in 1878, to ascertain whether or not said original drawings are still in the same condition that they were when you had charge of them in 1878 (the marks and numbers made for this interference excepted), and if so, when did you make that comparison and what was the result?

A. I have made that comparison, and to the best of my knowledge they are in the same condition as they were when they came into my hands about April, 1878, except that they have been taken from the books. I made the comparison this morning. 252

253 *Cross-examination by R. H. Brown, Esq.:*

10 x Q. Were the exhibits in this case the only ones that you traced?

A. No; they were not.

11 x Q. Did you at the time mentioned make tracings of all telephone drawings of Mr. Edison's?

A. I did of all I had at that time?

12 x Q. Do you know the particular date when you traced these exhibits?

254 A. I can't tell the exact date. I worked from six to eight months on the whole job. Part of the tracings of 1876 were made by Charles P. Edison and Mr. Craig. Those in 1877 I made myself.

WM. CARMAN.

255

256

STATE OF NEW JERSEY, 257
County of Middlesex, ss.:

At Menlo Park, in said County, on the 14th, 15th and 16th days of April, A. D. 1880, before me personally came the above-named Thomas A. Edison, Charles Batchelor, William Carman, and John Krucz, and made oath severally, that the foregoing depositions by them subscribed contain the truth, the whole truth, and nothing but the truth, the said depositions were taken at the request of Thomas A. Edison, at the time and place named in the notice hereto attached, to be used upon the hearing of an interference between the claims of the said Thomas A. Edison, and those of Charles E. Chinnock and Francis Blake, Jr., before the Commissioner of Patents, on the 15th day of July, A. D. 1880.

The said Chinnock & Blake were duly notified as appears by the original notice hereto annexed, and attended by their respective counsel, E. H. Brown, Esq., and J. J. Storrow, Esq.

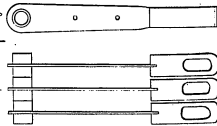
And I further certify, that the said witnesses were duly cautioned and sworn by me before commencing the testimony, and that the same was written out by George T. Pinckney, most of it in my presence, and that I am not related either by blood or marriage with either of the parties to this interference, and that I have no interest directly or indirectly in the matter.

[SEAL.]

S. L. GRIFFIN,
Notary Public.

259

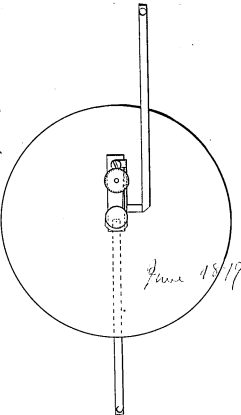
"Edison's Electric Spring 42-11"



"Edison's Electric Spring Hand 1897"



"Edison's Electric Spring 168-12"



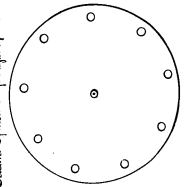
June 18/97



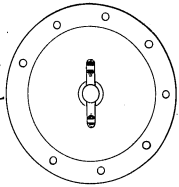
"Edison's Electric Spring and Control 112-11"



"Edison's Electric Spring 17-13"



"Edison's Electric Spring 168-12"



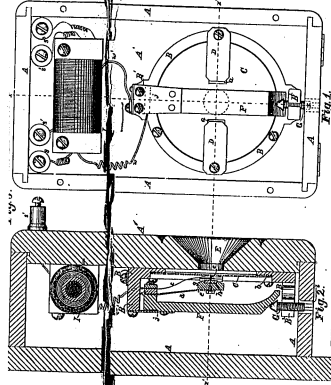
"Edison's Electric Spring 112-11"



A

Journal of Telegraphy
 vol. 10, 1877

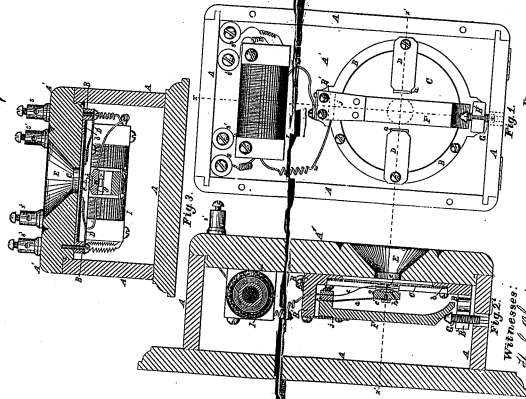
See page 506 A & B (new)



Inventor:
 James Clerk
 & W. H. Smith
 1877

Witnesses:
 H. B. Smith
 W. P. Smith Jr.

"Chimney Sweep A" S.L. 9



Witnesses:
 H. B. Whitely
 W. P. Ricks Jr.

Inventor:
 Francis M. Ricks Jr.
 by W. P. Ricks Jr.
 his atty.

IN THE UNITED STATES PATENT OFFICE.

IN THE MATTER

of

The Interferences between
THOMAS A. EDISON, FRAN-
CIS BLAKE, JR., and
CHARLES E. CHESNOCK.

TELEPHONE INTERFERENCES 2 AND 3.

Mr. Edison being called testifies as follows:

In further illustration of the inventions referred to in my direct examination in chief, I produce sketch 99-11, dated May 25, 1877, marked Edison's Exhibit 99-11, S. L. G., and 111-11, May 29, 1877, marked Edison's Exhibit 111-11, S. L. G., both of them were made by me on or before the dates affixed to each, the memoranda on them are in my handwriting, and each of them are signed by me and by Charles Batelдор and James Adams.

THOS. A. EDISON.

DECEMBER 9, 1880.

As between Edison and Blake it is consented that the foregoing may be added by the Notary to Mr. Edison's deposition, and stand as part of his testimony.

W. W. SWAN,
Attorney for Blake.

L. W. SERRELL,
Attorney for Edison.

Telephone Interferences [Volume 7]

Cases 4, 5, 6, and B³

The tables of contents, all preliminary statements and interfering specifications, and the evidence for Edison have been filmed. Edison exhibits that were filmed in Volume 2 have not been refilmed.

Lemuel W. Terrell
Argument & Notes &c.

IN THE MATTER OF TELEPHONE INTERFERENCES

NOW PENDING BEFORE THE COMMISSIONER OF PATENTS.

BLAKE.

WILSON.

EDISON.

Cases 4, 5, 6
and B³.

1. SUBJECT MATTER OF INTERFERENCES.
2. INTERFERING PARTIES.
3. PRELIMINARY STATEMENTS.
4. SPECIFICATIONS.
5. EVIDENCE OF EDISON.
6. " " BLAKE.
7. " " WILSON.

BOSTON:

ALFRED MUDGE & SON, LAW PRINTERS, 31 SCHOOL STREET.
1881.

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" " " 5 and 6	II
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EVIDENCE ON BEHALF OF WILSON.

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EDISON'S EXHIBITS.

In their order, after page 45.

191-11; 37-32; 105-12; "Spring Placers, Aug. 1877"; "Loose Diaphragm, Sept., 1877"; 136-12; "Musical Telephone, Sept., 1877"; "Articulating Transmitter, Oct., 1877"; 90-14; "Three-Spring Electrodes"; 1-13; 7-13; 16-13; 9-13; 104-12; 14-12; 16-13, additional; Edison's English patent, No. 2,500; 164-11; "Illustrated Diaphragm and Rubber Tube Damper"; "Edison's Carbon Telephone"; 190-11; 99-11; 30-11; 111-11.

BLAKE'S EXHIBITS.

In their order, after page 123.

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Exhibit No. 8, printed with testimony	page 79

United States Patent Office.

BLAKE }
WILSON }
EDISON. }

TELEPHONE INTERFERENCE,
4, 5, 6 and 1P.

RECORD.

DATES OF DECLARATIONS OF INTERFERENCE.

4, 5, and 6		Aug. 14, 1879.
1P		Oct. 18, 1879.

CASE 4.—Blake v. Wilson v. Edison.

SUBJECT MATTER.

The subject matter involved in the interference is, in combination with the diaphragm of a telephone a band of yielding material around the same at or near the edge, and a dampening finger. (Edison's first claim. Described and shown by Wilson and by Blake.)

INTERFERING PARTIES.

FRANCIS BLAKE, JR., of Weston, Mass. Application filed Jan. 3, 1879. Att'y of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

EDWARD L. WILSON, of Boston, Mass. Application filed May 21, 1879. Att'y of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

THOS. A. EDISON, of Menlo Park, N. J. Application filed June 2, 1879. (Case 178.) Att'y of record, L. W. Serrell, box 4689, New York, N. Y.

CASE 2. — Blake v. Edison.

SUBJECT MATTER.

The subject matter involved in the interference is the method herein described for holding the diaphragm of a telephone by means of springs pressing against one of its surfaces. (Blake's first claim. Described and shown by Edison.)

The adjusting lever shown for regulating the tension of the spring, which carries the outer electrode and the initial pressure between the two electrodes and against the diaphragm, as claimed by Blake (Claim 2) and shown and described by Edison.

INTERFERING PARTIES.

FRANCIS BLAKE, JR. Application filed Jan. 3, 1879. Atty of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

THOS. A. EDISON. Application filed June 2, 1879. (Case 178.) Atty of record, L. W. Serrell, box 4689, New York, N. Y.

CASE 3. — Wilson v. Edison.

SUBJECT MATTER.

The subject matter involved in the interference is a band of rubber or other similar elastic material applied to the disk of a telephone substantially as described to cover the edge and lap over upon both faces. (Wilson's claim. Shown in Edison's application.)

INTERFERING PARTIES.

EDWARD L. WILSON. Application filed May 21, 1879. Atty of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

THOS. A. EDISON. Application filed June 2, 1879. (Case 178.) Atty of record, L. W. Serrell, box 4689, New York, N. Y.

CASE 3¹. — Edison v. Blake.

SUBJECT MATTER.

The subject matter involved in the interference is the spring carrying the electrode coated with rubber or other similar soft

elastic material. (Blake's claim. Shown in Edison's model and drawing.)

INTERFERING PARTIES.

THOS. A. EDISON. Application filed June 2, 1879. (Case 178.) Atty of record, L. W. Serrell, box 4689, New York, N. Y.

FRANCIS BLAKE, JR. Application filed Sept. 11, 1879. Atty of record, W. W. Swan, 5 Pemberton Square, Boston, Mass.

CASE 4.

PRELIMINARY STATEMENT OF FRANCIS BLAKE, JR.

I first used a dampening finger in September, 1878. It was then used merely as a dampener, for I then slumped the diaphragm to its seat. I did not begin to use a band of yielding material between the diaphragm and its seat until I began to use a loose diaphragm, supporting it in its seat by spring fingers, as now shown. These spring fingers I continued to cover with rubber to give a dampening effect.

This latter construction was adopted in December, 1878, after the case was in my attorney's hands.

FRANCIS BLAKE, JR.

CASE 4.

PRELIMINARY STATEMENT OF EDWARD L. WILSON.

I first conceived the idea of applying a rubber band to the diaphragm of a telephone, as set forth in my said application, in the night of Jan. 2, 1879. The next morning, Jan. 3, 1879, I reduced the invention to practice by applying such a band to the diaphragm of a Blake transmitter.

The invention has been thus used, I believe, in the construction of all the Blake transmitters manufactured since Jan. 3, 1879, some 13,000.

E. L. WILSON.

CASE 4.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that either in May or June, 1877, he conceived the idea of covering the edges of the diaphragm with rubber, and made an instrument with such a diaphragm, about June 26, 1877; that he has a drawing of the same with that date upon it.

That during 1877 he made many telephones with diaphragms whose edges were coated with rubber, as also those diaphragms held against rubber by dampeners; that deponent has a diagram dated Oct. 4, 1877, showing two dampening fingers; that he has drawings and descriptions of various designs of dampeners and diaphragms resting on rubbers, dated in July, August, September and October, 1877; that a dampener is shown in Fig. 23, of British patent, No. 2,909, of July 30, 1877; that dampening fingers are shown in Figs. 86 and 87 of caveat No. 76, filed by deponent March 8, 1878; that these dampeners and diaphragms covered with rubber have been used by deponent, on both telephones and phonographs, in 1877, and since in various designs of telephones.

THOS. A. EDISON.

CASE 5.

PRELIMINARY STATEMENT OF FRANCIS BLAKE, JR.

The invention first mentioned in this interference was made soon after my attorney began to prepare my application for a patent, which was early in November, 1878. It was immediately put in practice, and has been followed ever since in the manufacture of the Blake transmitter.

The subject matter of the remainder of this interference, as I understand it, was invented in September, 1878.

At that time I made the adjustment in the manner represented, in my own instrument which I was then using.

Since Nov. 8 it has been used in all instruments made by the Bell Telephone Company, I believe.

Before September, 1878, I had other means for making the

adjustment, which, however, I do not understand to be the subject of this interference.

FRANCIS BLAKE, JR.

CASE 6.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that the method of holding a diaphragm by a spring against one of its surfaces was conceived by him as early as June, 1877, and reduced to practice in that month. The adjusting lever for regulating the tension of the spring which carries the outer electrode, and the initial pressure between the two electrodes and against the diaphragm, was reduced to practice by him about May 31, 1877, and was used by deponent in various telephones made and used by him since that time.

THOS. A. EDISON.

CASE 6.

PRELIMINARY STATEMENT OF THOMAS A. EDISON.

Thomas A. Edison, being duly sworn, deposes and says that the invention was reduced to practice as early as June, 1877. That it was conceived about May or June, 1877.

That it has been used at various times since that date as required in deponent's extensive experiments and tests in connection with telephones.

THOS. A. EDISON.

CASE 6.

PRELIMINARY STATEMENT OF EDWARD L. WILSON.

I first conceived the idea of applying a rubber band to the diaphragm of a telephone, as set forth in my said application, in the night of Jan. 2, 1879. The next morning, Jan. 3, 1879, I reduced the invention to practice, by applying such a band to the diaphragm of a Blake transmitter.

The invention has been thus used, I believe, in the construction of all the Blake transmitters manufactured since Jan. 3, 1879,—some 13,000.

E. L. WILSON.

CASE B.

PRELIMINARY STATEMENT OF FRANCIS BLAKE, JR.

I conceived, made, and put in practice the invention which forms the subject matter of this interference in the first week in January of this year. I believe the invention has been embodied in all the transmitters manufactured by the Bell Telephone Company since that time — many thousands in number.

FRANCIS BLAKE, JR.

PRELIMINARY STATEMENT OF THOS. A. EDISON.

Thos. A. Edison, being duly sworn, deposes and says that he is unable to give the exact date of the conception of the device in interference; but that between Feb. 9, 1877, and July 9, 1877, the same was practically operated. That the subject matter of this interference is also shown in deponent's application (No. 141), dated July 9, 1877, filed July 20, 1877, in Fig. 2 of the drawing.

THOS. A. EDISON.

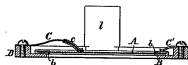


Fig. 2.

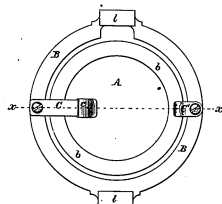


Fig. 1.

Witnesses:

H. M. Swann
L. P. Christy

Inventor:

Edw. Howard DeWitt

SPECIFICATIONS OF APPLICATIONS EMBRACED IN INTERFERENCES 4, 5, 6 AND 7.

EDWARD L. WILSON, OF BOSTON, MASS.

PENDING APPLICATION FILED MAY 21, 1879.

SPEAKING TELEPHONES.

To all whom it may concern:

Be it known that I, Edward L. Wilson, of Boston, in the State of Massachusetts, have invented an improvement in speaking telephones, of which the following is a specification:—

The invention relates to the diaphragm or vibrating plate of the speaking telephone, and consists in a modification of the cushion of that member of the instrument.

Heretofore it has been customary to interpose between the diaphragm and its bed or frame a rubber ring or a ring of blotting paper, or similar elastic non-conducting substance, and sometimes a similar ring has also been applied to the diaphragm on the side opposite the bed. But this has left uncovered the edge proper of the diaphragm. I have found that better results are obtained by covering also this edge and for this purpose I make use of a rubber band, the internal diameter of which, when not stretched, is less than that of the diaphragm. This band is stretched over the edge of the diaphragm so as to form what may be termed a binding for it, covering the edge proper, and extending upon both faces from the edge towards the centre for the distance of about a quarter of an inch. The band should be small enough to exert in a small degree a pressure towards the centre of the diaphragm, so as to render the diaphragm slightly concavo-convex.

It will be found that by the application of an elastic band to the diaphragm certain troublesome overtones are avoided, which are present when the edge proper is left bare.

In the drawings, Fig. 1 is a front elevation of the diaphragm resting in its bed, and Fig. 2 is a section on dotted line, *x x*, of Fig. 1.

A is the diaphragm. B is the metallic ring or frame for supporting the diaphragm and other mechanism of the telephone; the diaphragm resting on a lip or edge of the ring, B, as shown, and the other mechanism (not shown) being supported by two ears, *l l*, projecting from the ring. The band of rubber or similar material as above described is marked *z*.

C is a spring; and C' a clamp attached to the metal ring or frame, B, and holding the diaphragm in place. The free end of the spring, C, is coated with rubber, *c*, while the free end of clamp, C', presses against the rubber band, *z*. *But this method of holding the diaphragm in place by springs and clamps forms no part of my invention; for I believe the same to have been invented by Francis Blake, Jr., who I am informed has applied for Letters Patent therefor.**

I claim: A band of rubber or other similar elastic material, applied to the diaphragm of a telephone substantially as described, to cover the edge and lap over upon both faces for the purpose specified.

EDWARD L. WILSON.

WITNESSES:

W. W. SWAN.

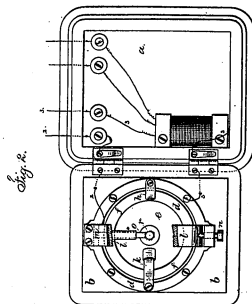
H. G. OLMSTED.

* Part in *Italics* inserted by amendment, July 7, 1879.

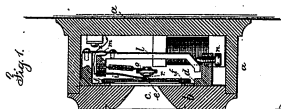
T. A. EDISON.

APPLICATION No. 178.

FILED JUNE 2, 1879.



Case 178.



Witness
Charles McKim
Geo. D. Brockway

Inventor

Thomas A. Edison
 per *Lemuel W. Powell*

THOMAS A. EDISON, OF MENLO PARK, N. J.

Assignor to Western Union Telegraph Company, of New York, N. Y.

PENDING APPLICATION FILED JUNE 2, 1879. (No. 178.)

TELEPHONES.

To all whom it may concern:—

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, have invented an Improvement in Telephones, Case No. 178, of which the following is a specification:—

This invention relates to what is known as the carbon telephone, in which the sonorous waves are translated into electric waves by means of the variable pressure exerted upon finely divided material, such as lampblack, carbon, graphite, or other material acting in a similar manner, and placed in the electric circuit.

In my patent, No. 203,014, I have shown a diaphragm, and adjustable springs with pieces of carbon or plumbago, adjacent to the diaphragm, and also a piece of rubber across the diaphragm. In my patent No. 203,016, there is set forth a compressed carbon button between two plain disks that are in the electric circuit, and the vibrations of the diaphragm vary the pressure upon the carbon button in proportion to the amplitude of the vibration. In my patent No. 204,013, there is an elastic cushion in connection with the diaphragm and the circuit conductor.

In my application No. 161, there is a diaphragm, and a carbon button supported by a yielding lever, and in my application No. 168, filed Nov. 11, 1878, there is a diaphragm and a body acting by inertia upon the circuit-regulating button, that is between the diaphragm and said body.

More or less of the features heretofore referred to enter into this present application, but it is to be distinctly understood that I do not herein lay any claim to either of the devices shown in such former applications.

My present invention relates to a diaphragm surrounded with a band of India rubber or similar yielding material, to allow of the vibration of such diaphragm by the action of the sonorous waves, but to check or arrest any prolonged or false vibrations, in *combination* with [and it further relates to] an elastic dampening finger resting

Part in brackets near foot of page struck out by amendment.
Text in italics near foot of page inserted by amendment.

upon the diaphragm, and also to two adjustable springs or spring arms, between which is placed a piece or button of carbon, graphite, or similar material acting by the pressure from the diaphragm to vary the resistance in the circuit.

In the drawing, Fig. 1 is a vertical section of the telephone, and Fig. 2 is a rear view of the diaphragm, with the lever bar partially removed.

The box *a* is of any suitable character, and the front *b* is provided with a mouthpiece or opening at *c*.

d is a metal ring or frame, and *e* is the diaphragm. *f* is a ring of india rubber or similar yielding material, that interposes between the edge of the diaphragm and the frame *d*, to allow of the vibration of the diaphragm, and to check any false vibrations of the same. *h* is the clamp to hold the diaphragm near one edge, and *k* is a spring finger, armed at the end with india rubber, or similar yielding material, pressing upon the diaphragm near the middle to hold it in place, and also to act as a damper to lessen false vibrations.

The spring arms *i* and *o* are insulated from each other, but connected with the circuit wires 2 and 3, and between them is the button of graphite or equivalent material at *r*.

The spring *i* is in contact with the diaphragm, and it will receive motion from the sonorous vibrations that act upon the diaphragm, and vary the pressure upon the graphite and produce rise and fall of the electric tension.

The metallic disk at the back of the piece of carbon acts by inertia, as a resistance; the spring arm *o* is also stiffer than the spring *i*.

The lever bar *l* is connected with the frame *d* by means of the spring *m*, and said lever bar forms the support for the ends of the spring *i* and *o*, so that by moving this lever bar the pressure of *i* on the diaphragm can be regulated. The screw *n* holds the lever bar *l* in position when adjusted.

One circuit wire 3 may be connected to the frame *d*, the other to the insulated spring *i*. The springs *i*, *o* are in a local circuit in which is contained a battery and the primary helix of an induction coil, which in turn translates the electric waves of the primary into the secondary coil which is included in the line circuit.

The word "also" in italics inserted by amendment.

I claim as my invention,

First. In combination with the diaphragm of a telephone, a band of yielding material around the same, at or near the edge, and a dampening finger for the purposes set forth.

Second. The springs *i* and *o*, in combination with the piece of graphite or similar material between them, and the diaphragm of a telephone instrument, substantially as set forth.

Signed by me, this thirtieth day of May, 1879.

THOMAS A. EDISON.

Witnesses:

STOCKTON L. GRIFFIN,
WM. CARMAN.

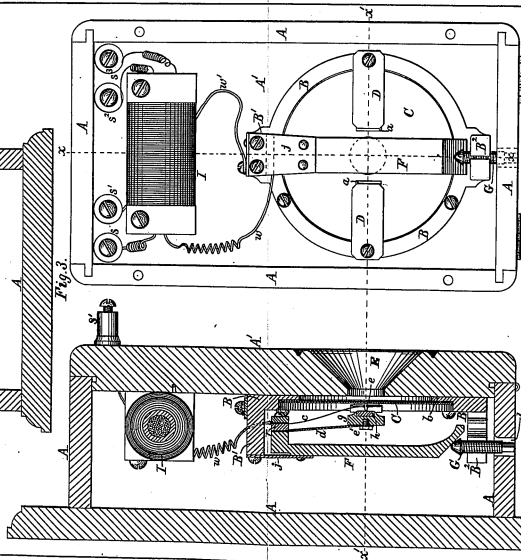
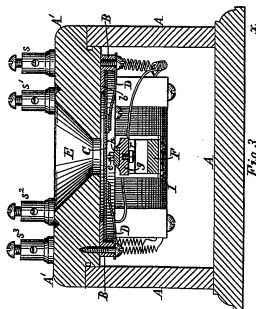


Fig. 1.

Inventor:

Francis Blake Jr.

Witnesses:

William W. Luman

H. G. O'Connell

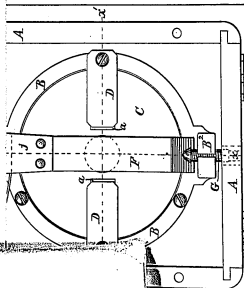


Fig. 1.

Inventor:

Francis Blake, Jr.

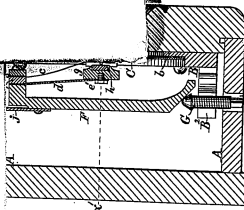


Fig. 2.

Witnesses:

William W. Swan
E. J. Chubb

FRANCIS BLAKE, JR., OF WESTON, MASS.

PENDING APPLICATION FILED JAN. 3, 1879.
IMPROVEMENT IN TELEPHONES.

To all whom it may concern:

Be it known that I, Francis Blake, Jr., of Weston, in the State of Massachusetts, have invented certain new and useful Improvements in Speaking Telephones, of which the following is a specification:—

[One of my said improvements has reference to a method of holding the diaphragm of a telephone so that it will be free to expand or contract without altering its form.] My other said improvements relate to that form of transmitting telephone in which the undulations or variations in the strength of an electric current necessary for reproducing sounds in a receiving instrument are produced by varying the resistance of the circuit through changes of pressure between two electrodes of the circuit. As heretofore constructed, one of the electrodes in such instruments is held in fixed position, while the other, being free to move to some extent, is constantly held in contact with such fixed electrodes, and is pressed against it with greater or less force by the vibrations of the diaphragm with which it is connected.]

My said improvements relate to that form of transmitting telephone in which the undulations or variations in the strength of an electric current necessary for reproducing sounds in a receiving instrument are produced by varying the resistance of the circuit through changes of pressure between two electrodes of the circuit. As heretofore constructed, one of the electrodes in such instruments is held in fixed position while the other, being free to move to some extent, is constantly held in contact with such fixed electrode and is pressed against it with greater or less force by the vibrations of the diaphragm with which it is connected. In using an instrument of this form it has been found necessary to adjust the initial static pressure between its electrodes with great care and delicacy in order to secure such a

* These words in Italics inserted by amendment filed Feb. 7, 1879.
Paragraph in brackets struck out by amendment of May 8, 1879.
Paragraph in Italics inserted by amendment of May 8, 1879.

variation of resistance between them under the vibrations of the diaphragm as will enable the current to reproduce in a receiving instrument the sounds which fall upon the transmitting instrument. When such an adjustment has been secured, it is easily disturbed by slight causes, such as a change in the temperature of the instrument, or a trifling movement of some of its parts in relation to other parts.

By my inventions the proper adjustment is easily secured, and is not liable to be disturbed in the practical use of the instruments. I support both electrodes in such a manner that they can move freely with the diaphragm. One of them may be attached directly to and be supported by the diaphragm, but I prefer to support it in contact with the diaphragm but by an independent support.

The other electrode is supported so as to move freely, but is made so heavy, or is so weighted, that by its inertia it will offer a resistance to the slight and quick vibrations of the diaphragm, which will give a varying pressure between the electrodes and a consequent change in the resistance of the circuit. This second electrode is so supported that the initial static pressure between the two will not be sensibly affected by a change of temperature within the ordinary range of temperatures to which such instruments are exposed. It is on the end of a spring, the other end of which is connected to a lever by means of which the proper initial pressure between the electrodes and against the diaphragm is obtained.

To secure contact between the electrodes independently of the pressure against the diaphragm, I support the one next to the diaphragm upon a spring which exerts its pressure against the opposite electrode.

The manner in which I construct instruments, embracing my invention, is shown in the drawings hereto annexed, in which A represents a box or casing in which the mechanism of a telephone embracing my improvements is enclosed. This mechanism is for convenience attached to the cover or top of the box (A').

Fig. 1 is a plan of the mechanism attached to the top or cover of the box. Fig. 2 is a section of the box and mechanism taken through the middle on the dotted line $z z$ of Fig. 1, and showing one of the screw-cups for making connections with the exterior cir-

cuits. Fig. 3 is a cross section of the box and mechanism on the dotted line $x' x'$ of Figs. 1 and 2, and showing the screw-cups for making connections with the exterior circuits.

It represents a metal ring or frame for holding the mechanism of the telephone. It is screwed to the cover A' as shown, and has two ears W W'. On the inner surface of the ring B is a narrow ledge or lip b on which the disk or diaphragm C is placed. This diaphragm is formed as usual of a thin iron plate. A lining of paper or other suitable material is placed between it and the ledge or lip, and it is held in place by two springs D D, attached to the metal rim or ring B, with their free ends pressing upon the back of the diaphragm near its centre so as to hold it against the ledge. Thin pads of rubber a a are placed between the ends of the springs and the diaphragm. By this method of holding the diaphragm in place, it is less liable to be distorted by a change of temperature than when held wholly at its circumference.

The centre of the ring and diaphragm is placed opposite the orifice E in the cover A' through which the sounds enter the instrument. On the other side of the diaphragm and at its centre is placed one of the electrodes. It is a small metal bar (e), one end of which rests against the diaphragm, the other end is brought nearly to a point and is in contact with the other electrode (e'). It is desirable that it should be formed of or plated with some metal like platinum or nickel, which is not easily corroded. It may be attached directly to the diaphragm, but I prefer to support it independently, as shown, upon a light spring e, which tends to press it away from the diaphragm and towards the opposite electrode.

This method of supporting the electrode insures its contact with the other electrode under some circumstances, when otherwise they would be liable to be separated and the circuit broken.

The other electrode e' is formed on a weighted spring f, which is supported on an adjusting lever F, by which the tension of the spring is regulated. This spring must be stronger than the spring e which supports the electrode e, and from its greater strength, it tends to keep the electrode e' in contact with the diaphragm. It may be made of a piece of a common watch-spring, and it carries at its free end a weight g, heavy enough to check very greatly the

rate of vibration of the spring. This weight may be of metal, which may serve directly as the electrode, but I have obtained better results by applying to it, at the point of contact with the other electrode, a piece of gas coke or a hard pressed block of carbon *b*, such as is used for electric lights.

The employment of the coke or carbon does not, however, constitute a part of my invention further than it contributes a portion of the weight carried by the spring. If the weight is a non-conductor, as it may be, there must be a metallic conductor between the carbon or other electrode used and the spring or some other part of the circuit. The weight must be proportioned to the stiffness of the spring, a stiff spring requiring a heavier weight than a weaker one. The adjusting lever *F*, to an arm of which one end of the spring *d* is attached, is a stiff bar, connected at one end by a stiff spring *j* to the ear *IV* of the ring *h*. The other end rests upon an adjusting screw *G*, placed in the ear *IV* on the opposite side of the ring. The spring *j* tends to force the lever *F* away from the diaphragm and against the adjusting screw *G*.

The ear *IV* supporting the adjusting screw *G*, is drilled and slotted as shown in Figs. 1 and 2, to prevent the screw from wearing loose.

The part of the lever *F*, which comes in contact with the screw, is inclined to the axis of the screw, as shown, so that when the screw is forced inwards, it will press the lever towards the diaphragm, and when it is withdrawn the lever will, by the tension of the spring *j*, be forced away from the diaphragm. The outer end of the screw *G*, extends into a hole *l* through the casing, and is fitted to receive a key by which it can be turned to adjust the lever to a desired position.

The pressure between the two electrodes, and against the diaphragm obviously depends upon the position given to the adjusting lever by the adjusting screw *G*, but it is obvious that as this pressure can be increased or diminished only by increasing or diminishing the tension of the spring *d*, the changes in the pressure by turning the screw will be much less rapid than they would be if the electrode was acted upon directly by the lever or the adjusting screw. Hence a proper adjustment of the initial static pressure between the electrodes can be much more easily obtained through

the agency of the spring *d* than without it. It will also be easily seen that this pressure will not be sensibly affected by any slight change in the position of the electrodes which might arise from the expansion or contraction of any part of the apparatus under a change of temperature. On the other hand it will be seen that if the diaphragm is thrown into the rapid but slight vibrations caused by sounds, the spring alone would yield to them so readily as to give but little change of pressure between the electrodes within the range of the vibrations, but by reason of the inertia of the weight, the tendency of the spring to follow the vibrations of the diaphragm will be checked, and a greater range of pressures between the electrodes will be obtained. At the same time it is easy to see that the changes of pressure will be very different from what they would be if the electrode was supported rigidly, and could not yield to the movements of the diaphragm.

I have before stated in substance that the main feature of my improvements will be obtained even when the electrode *e* is attached directly to the diaphragm, but it should be observed that an additional improvement is gained by supporting that electrode on an independent spring which keeps it in contact with the electrode *e*, for it not unfrequently happens when the intermediate electrode is attached directly to the diaphragm that a too rapid vibration of the diaphragm or some other disturbance in its vibrations will throw the outer electrode out of contact with the intermediate electrode, and thus break the circuit; but in my construction, such irregular vibrations of the diaphragm will separate the diaphragm from the intermediate electrode *e* rather than separate the two electrodes from each other, and the circuit will not be broken.

For convenience in construction, when employing the independent spring *e* for the purpose just stated, I attach it to the same arm of the adjusting lever *F*, to which the spring *d* is attached, the two springs being separated by a piece of insulating substance *r*; but the spring *e* might be attached to any convenient portion of the instrument if properly insulated.

The wires for connecting this transmitting instrument with the receiving telephone are marked *w* and *w'*. I have, however, shown them as connected with the primary circuit of an induction coil, *I*, in connection with which *s* and *s'* are the screw-cups leading to the

battery, while s' , s are screw-cups for connecting the line wires with the secondary circuit of the coil 1.

The use of the induction coil is not essential, and the wires e e' may go at once to the receiving instrument. The wire e is connected directly with the spring arm c of the electrode c , as shown in Fig. 2. The wire e' is connected with one of the ears of the ring 11, as shown in Fig. 3, which is in metallic connection with the electrode e' , as shown in Fig. 2.

I claim,

First. The method herein described for holding the diaphragm of a telephone by means of springs pressing against one of its surfaces.

[Second.] A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movements of the diaphragm substantially as described.]

[Third.] SECOND. The adjusting lever F for regulating the tension of the spring d , which carries one of the electrodes (e'), and the initial pressure between the two electrodes e , e' , and against the diaphragm, substantially as described.

[Fourth.] THIRD. The combination of the two electrodes by means of springs acting against each other, substantially as described, to maintain the electrodes in contact when forced away from the diaphragm.

[Fifth.] FOURTH. [A] The yielding weight g [substantially as described] connected with the movable electrode e' , to resist the movement of the diaphragm and modify by its inertia the variation of pressure between the two electrodes, substantially as described.

WITNESSES:

FRANCIS BLAKE, Jr.

H. G. OLMFIST,

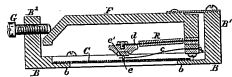
W. W. SWAN.

The words and letters in the claims in italics inserted by amendment, Feb. 5, 1879.

The words in small caps inserted by amendment, May 10, 1879.

Parts in brackets struck out by amendment, May 10, 1879.

NOTE.—The application of Blake was filed Jan. 2, 1879, and contained five claims, as above. May 10, 1879, this application was divided, the 1st, 3d, 4th and 5th claims remaining in the original case as already amended, but renumbered as 1st, 2d, 3d, and 4th, and a new application of that date filed, covering the 2d claim. The original specification and claims above printed, with the amendments shown, constitute the case involved in these interferences, Nos. 2 and 3.



Witnesses:

Chas. H. H. H. H.
H. H. H. H.

Inventor:

Francis Blake Jr.
by atty.
W. H. H. H.

FRANCIS BLAKE, JR., OF WESTON, MASS.

PENDING APPLICATION FILED SEPT. 11, 1879.

IMPROVEMENT IN TELEPHONES.

To all whom it may concern:

Be it known that I, Francis Blake, Jr., of Weston, in the State of Massachusetts, have invented an improvement in speaking telephones, of which the following is a specification:—

The invention relates to a form of speaking telephone invented by me and described in an application for a patent filed in the Patent Office Jan. 3, 1879, and consists in covering with rubber, or similar material, the spring carrying the weighted electrode of that instrument, whereby certain troublesome overtones due to the vibrations of the spring may be avoided.

In the drawings I have shown so much of my said instrument as will fully illustrate the present invention.

As in my said other application, the ring, or frame, for supporting the mechanism of the telephone, is marked "B." The diaphragm is marked "C." It rests upon a lip *b* of the ring B, being separated therefrom by a lining of paper or other suitable material, and being held in place as described in said other application by flat springs, not here shown.

The ring B has two ears, D, B', the ear B' supporting an adjusting lever F, which in turn carries the light spring C with the electrode *c*, and the heavy spring *d*, with its weighted electrode *e*, and also carries the ear B', supporting the adjusting screw G, all as here shown and substantially as shown and described in my said former application.

Accordingly, in this application I make no claim to any of the devices herein described and shown, except when modified as follows:—

As before stated, the heavier spring *d*, which is strong enough to keep and does keep the two electrodes in constant contact, notwithstanding the vibrations of the diaphragm, is covered with a tube of

BLAKE'S SPECIFICATION. (APPLICATION, SEPT. 11, 1892.)

rubber R for the purpose of doing away with certain overtones, which, resulting from the vibrations of that spring, might otherwise accompany the transmitted sounds. Substantially the same effect can be obtained by coating the strip with leather, blotting paper, or other similar soft, elastic material, and instead of being applied in the form of a tube, the rubber or other soft elastic material may be cemented in strips to the flat side or sides of the spring, or secured in any similar manner. I claim—

The spring *d*, coated with rubber or other similar soft elastic material, substantially as described for the purpose specified.

FRANCIS BLAKE, JR.

Witnesses:

CHAS. H. SWAN.

H. G. OLINSTEAD.

IN THE
U. S. Patent Office.

In the matter of the Interference between the Applications for Patent on

TELEPHONES
of

THOMAS A. EDISON, EDWARD
L. WILSON and FRANCIS
BLAKE, JR.

*Interferences Nos. 4, 6,
and 6, & 13*

NEW YORK, Oct. 6th, 1880.

W. W. SWAN, Esq.,

Att'y for E. L. Wilson and F. Blake, Jr.:

SIR:

Please take notice that on Friday, October 8th, 1880, at the laboratory of T. A. Edison, Esq., Menlo Park, New Jersey, commencing at 10½ o'clock A. M., and before a proper officer, I shall proceed to take the depositions of Thomas A. Edison, Chas.

- 4 Batchelor, John Kruesi, and William Carman, of Menlo Park, New Jersey, and perhaps others, as witnesses on behalf of T. A. Edison in above named cases.

The examination will continue from day to day until completed.

You are invited to be present and cross-examine said witnesses.

LEMUEL W. SERRELL,
Att'y for T. A. Edison.

- 5 Service of a copy of above notice acknowledged this 7th day of October, A. D. 1880.

W. W. SWAN,
Att'y for Wilson.

W. W. SWAN,
Att'y for Blake.

IN THE
UNITED STATES PATENT OFFICE.

In the matter of Interference between the Applications for Patent on

TELEPHONES

of

THOMAS A. EDISON
and
FRANCIS BLAKE, JR.

*Interferences Nos. 5, 6
and D 3.*

NEW YORK, Oct. 6th, 1880.

W. W. SWAN, Esq.,
Attorney for F. Blake, Jr.:

SIR:

Please take notice that on Friday, October 8th, 1880, at the laboratory of T. A. Edison, Esq., Menlo Park, New Jersey, commencing at 103 o'clock A. M., and before a proper officer, I shall proceed to take the depositions of Thomas A. Edison, Chas. Batchelor, John Kruesi, and William Carman, of Menlo Park, New Jersey, and perhaps others, as witnesses on behalf of said T. A. Edison in above named cases.

The examination will be adjourned from time to time until completed.

You are invited to be present and cross-examine said witnesses.

LEMUEL W. SERRELL,
Att'y for T. A. Edison.

- 10 Service of a copy of foregoing notice acknowledged this 7th day of October, A. D. 1880.

W. W. SWAN,
Att'y for Blake.

IN THE

UNITED STATES PATENT OFFICE.

Before HON. COMMISSIONER OF PATENTS.

11

IN THE MATTER

of
Interferences on Telephones

Between the Application of
THOMAS A. EDISON, filed
June 2, 1879, and that of
EDWARD L. WILSON, filed
May 21, 1879, and that of
FRANCIS BLAKE, JR., filed
Jan. 3, 1879,

Interference No. 4.

and

12

Said Application of T. A.
Edison and that of F.
BLAKE, JR.,

Interference No. 6.

and

Said Application of T. A.
Edison and that of EDWARD
L. WILSON,

Interference No. 8.

5

and

13

Said Application of T. A.
Edison and that of FRANCIS
BLAKE, JR., filed Sept. 11,
1879.

Interference B3.

Depositions of witnesses examined on behalf of
said Thomas A. Edison, pursuant to annexed no-
tices, at the Laboratory of said Edison, at Menlo
Park, New Jersey, October 8th, 1880.

Present—

LEMMUEL W. SERRELL, Esq., on behalf of
Mr. T. A. Edison; W. W. SWAN, Esq.,
on behalf of E. L. Wilson and Francis
Blake, Jr.

14

THOMAS A. EDISON, being duly sworn, deposes
and says, in answer to interrogatories proposed by
Lemuel W. Serrell, Esq., counsel for T. A. Edison,
Esq., as follows:

Q. 1. Please state your name, age, residence and
occupation?

A. My name is Thomas A. Edison; thirty-four
years of age; residence, Menlo Park, N. J.; occu-
pation, inventor.

Q. 2. The subject matter of interference No. 4, is
as follows:

15

"In combination with the diaphragm
of a telephone a band of yielding
material around the same at or near
the edge and a dampening finger."

Count 4

The subject matter of Int. No. 5 is as fol-
lows:

"The method herein described for holding the

Count 5

"diaphragm of a telephone by means of springs
"pressing against one of its surfaces."

"The adjusting lever shown for regulating the tension of the spring, which carries the outer electrode and the initial pressure between the two electrodes and against the diaphragm."

The subject matter of lat. 16 is as follows:

"The spring carrying the electrode coated with
"rubber, or other similar soft elastic material."

Please state when you invented the same, and under what circumstances to describe the telephones embodying these features and the order in which they were made?

17 A. In the subject matter of case 4 I either in May or June, 1877, conceived the idea of covering the edges of a diaphragm with rubber.

On June 26, 1877, I made a sketch in which was a diaphragm, whose edges on both sides were covered with rubber rings. I produce the sketch—it is the top figure in such sketch.

(Sketch offered in evidence, marked Edison Exhibit 191-11).

This Exhibit is dated June 26, 1877, signed by myself, and witnessed by Chas. Batchelor and James Adams, my assistants.

18 The diagram was merely a sketch to convey to my assistants the idea as to how the experiment was to be tried, and is not a diagram of the instrument as constructed. This sketch shows a resonant tube with a screw upon the end of it; over this screw was screwed a ring of metal. Against this ring was placed a diaphragm covered with rings of soft rubber on both sides. In the actual instrument constructed I believe the diaphragm was held against this ring by springs. July 20, 1877, another diagram was made, in which the diaphragm had rings of soft rubber on each side of it

near its edges—the explanations are upon the diagram itself. This Exhibit is witnessed by my two assistants, Chas. Batchelor and J. Adams. I refer to Exhibit 37-12—the figures referred to are in the lower portion of the sheet.

Diagram offered in evidence, marked Edison's Exhibit 37-12.

37-12

The object of the rubber was to increase the sensitiveness of the diaphragm by allowing it to have a greater amplitude, and also to get rid of the harmonic sounds of the metal, as well as to keep the diaphragm flat at all times by allowing it to expand and contract without bulging.

It accomplished these results for the reason that being clamped by a soft material the diaphragm when expanded by heat would cause the rubber to give, and it would remain perfectly flat, whereas if it, the diaphragm, was clamped rigidly between metallic plates it must necessarily bow outwardly by expansion. Again, it was impossible, except at great cost, to so thoroughly clamp a diaphragm between metallic rings that at some point it would not be a little loose and produce a harmonic or other sounds not wanted when the diaphragm was regulated by the voice.

In Exhibit 37-12 the portions showing the india-rubber rings consist, 1st, a ring marked "out ring" meaning the outer ring.

2d. A disk marked "dia," which is the diaphragm.

3d. A ring marked "in ring," meaning inner ring. Next to this is two metallic rings represented between which is a diaphragm with the rubber rings on each side of the same.

Over these figures is the following instructions to my assistants:

// "Put rubber or other soft substance rings between the diaphragm on the rings."

The instrument was made pursuant to these instructions within one or two days after the date of the exhibit.

We used the instrument, and about that time made many instruments with the diaphragm covered with rubber, near its edges, on both sides. In the same exhibit there are drawings of four diaphragms, resting upon a sheet of rubber or other diaphragms stretched across a ring.

The diaphragm held upon the rubber.

23 These diaphragms were formed of disks, with leaves extending from them, and also in the form of strips. Instruments containing these various forms of diaphragm, resting upon rubber, were made within a few days after July 20, and used.

The result was not so satisfactory, so far as the shape of the diaphragm is concerned, as the diaphragm covered with rubber upon each of its edges.

These were compound diaphragms of two thicknesses, one of rubber and the other of metal.

// I have here a diagram, dated Aug. 12, 1877, and signed by myself, and witnessed by my two assistants, Chas. Batchelor and James Adams.

24 The second figure from the top shows the diaphragm resting upon two strips of rubber, and I mention underneath the figure the following:

"Soft rubber to densen the diaphragm, it works well, prevents harmonics or excessive vibrations; hard pieces of rubber or equivalent could be placed in different parts of the diaphragm and held against it by adjusting screws to dampen it."

These pieces of rubber held against the diaphragm, and made adjustable by screws to dampen

it, is not shown in the figure, for in this case the greater or lesser dampening effect was produced by a greater or lesser stretching of the rubber strips passing over and in contact with the surface of the diaphragm.

The rubber performing the function of the spring or dampening finger as well as acting as a densening material. (Diagram offered in evidence marked Edison's Exhibit 105-12.)

The sketch 105-12 shows the application of the dampener in connection with a receiver, and a transmitter, but the dampener will of course act the same with a transmitter.

About August, 1877, I constructed several telephones in which the diaphragm was loose and rested upon soft rubber near its edges, and was held there by two flat springs pressing upon the diaphragm near its edges. I have no drawing of the same that I have been able to find, but remember of having made several instruments of this character.

I now make a drawing illustrating this instrument, showing the case, the rubber, and the spring fingers without the diaphragm.

Sketch offered in evidence and marked
Exhibit Edison's spring fingers, Aug.
1877. 27

This form of instrument was abandoned, as it was used as a receiver and the springs would catch in the hair of the person listening.

A short time afterwards, perhaps three weeks, we dispensed with the fingers, and made the ear of the listener perform the same function as the springs did, in holding the diaphragm against the rubber, and also dampening the diaphragm.

I produce one instrument made some time in Sept., 1877, showing this alteration. It consists of

105-12

Aug 12. 1877

a loose diaphragm resting upon rubber. The diaphragm being adapted so as to allow it to be held against the rubber, and dampened by pressing the instrument slightly against the same.

Instrument offered in evidence, and marked "Edison's Exhibit Loose Diaphragm, Sep. 1877."

The object of the little extension in the diaphragm was for the purpose of preventing it from falling off when taken from the ear; at the same time allowing the diaphragm to be sufficiently loose, so that it was pressed against the rubber and dampened at the same time, when placed against the ear.

I think about 100 of these instruments were made about September, 1877, and sold and delivered to the Western Union Telegraph Company.

I have here a sketch dated August 30, 1877, signed by myself, and witnessed by my two assistants, Charles Batchelor and J. Adams.

In this sketch are two diagrams, one at the bottom of the page and one immediately over it; both show the diaphragm as loose and resting upon the rubber.

(Sketch offered in evidence, marked Edison's Exhibit, 136-12.)

In the bottom figure no means are shown for preventing the diaphragm from falling off, but in the figure above it, extensions are shown bent over on the side of the case, as in exhibit loose diaphragm.

The diaphragm had a hollow core fastened to its center, against which the ear was pressed.

These forms were made and used within two or three days after the date of the exhibit.

I then produce one of several instruments made for transmitting musical sound. I think this one

was made and used, certainly, before the last of September, 1877.

It contains a diaphragm with rubber rings on both sides, near the edge.

In addition to the rubber rings, there was a paper ring; in this case the diaphragm was held by a metallic ring resting upon the paper and screwing into the diaphragm holding ring.

Public exhibition of the transmission of musical sounds, with the aid of this instrument and others like it, were made by my assistant, E. H. Johnson, in different parts of the country.

The instrument described was made for use for transmitting unarticulated sounds, but can be used for transmitting articulated sounds, when carbon electrodes or point are substituted for the platinum points.

(Instrument introduced in evidence and marked "Edison's Musical Telephone, Sept., 1877.")

I next produce one of a lot of a large number made about sometime in August or September, 1877 which contains a loose diaphragm resting upon a rubber diaphragm, and dampened by a rubber finger, which is adjustable.

The adjustable finger also acts to increase or decrease the initial pressure between the two electrodes against the diaphragm, as in second count, case 3.

It also meets the count in case 4, as there is a combination with a diaphragm of a telephone of a band of yielding material around the edge and a dampening finger.

It also meets the 1st count of case 5, inasmuch as the diaphragm is held by means of a spring pressing against one of its surfaces, which spring is also a dampener.

Exhibit loose dia
Sep. 1877.

100 sold
Sept. 1877

136-12

Sept 1877

30
2nd Count case 5

Count case 4

1st Count case 5

THOMAS A. EDISON.

*Articulating
Transmitter*

34

(Instrument offered in evidence and marked "Edison's Articulating Transmitter, October, 1877.")

In my application No. 128, the carbon material is between two springs, so as to allow the pressure to be applied to the carbon between such springs without preventing the vibration of the diaphragm.

In the Exhibit called Edison's Articulating Transmitter, October, 1877, there are two electrodes with carbon between them. The one electrode towards the diaphragm is a spring, while the other is rigid; but the diaphragm is provided with a spring in the form of a rubber tube, which allows the pressure to be put on the carbon, and at the same time allows the diaphragm to radiate freely, and this spring of rubber tube admits of any degree of initial pressure to be put upon the two electrodes, when moved to, and in contact with, the diaphragm.

If, as in my application No. 178, the weight of the electrode was connected rigidly to the lever, i. e. the placing of a rubber tube between the diaphragm and the spring *i*, would produce the same result; the rubber tube spring taking the place and performing identical functions with the weighted spring.

Again, in my application No. 178, the object of the arm *L* is to raise the electrodes to advance or recede from the diaphragm, so that the varying initial pressure between the two electrodes when brought in contact with the diaphragm can be made. This is accomplished by means of the screw *n*.

In the case of the instrument marked Edison's Articulating Transmitter, October, 1877, the lever, so to speak, is made rigid, in the form of a curve bar, and the screw, *n*, is placed through its center and forms one of the electrodes, and being a screw will allow the electrodes to be adjusted to,

THOMAS A. EDISON. 37

and from the diaphragm putting on a greater or lesser initial pressure between the two electrodes.

If the cross-bar was pivoted at one end, and the screw which fastens it to the frame was made to raise and lower it, the design with that shown in application No. 178, would be identical, but the principle of operation is the same without this pivot.

I think about 100 or 150 transmitters of which Edison's Articulating Transmitter, Oct. 1877, is one, were made either in September or October, 1877, they were made by Mr. J. T. Murray, of New York, by order of The Western Union Telegraph Co. and delivered to the said Company, soon after.

The lot that I here speak of were made exactly like Exhibit marked Edison's Articulating Transmitter, October, 1877. The Exhibit itself is marked No. 37.

About September, 1877, an instrument was made and used almost precisely like that shown in my application No. 178, with the exception that the lever (*i*) was pivoted instead of being secured by a spring. It was adjusted by a screw sliding on an incline. The spring (*i*) was fastened, not to the lever, but to the spring carrying the other electrode.

I have neither a drawing or model of the exact design, but I am certain that I made several forms of this kind.

In September 22, 1877, I made a drawing of a lever pivoted at one end and adjusted at the other by means of a screw, with a spring on the lever, but in this case the diaphragm acted as one spring and the lever as another.

This Exhibit is signed by myself and witnessed by my assistant, Charles Faircler. I remember having made it, and I have a model somewhere in my possession, but it has been mislaid.

*Murray Oct
1877, made the
Articulating Trans-
mitter.*

*36.11
Sep 22. 1877*

40 THOMAS A. EDISON.

(Drawing offered in evidence and marked Edison's Exhibit, 36-13.)

This instrument shown in Edison's Ex. 36-13 was used, and I believe a number of them with the electrode placed on the lever in different ways were made. In this case, Ex. 36-13, the diaphragm acted as a spring on an electrode, while the lever acted on a spring in the other electrode.

The lever getting its spring from the spiral around the adjusting screw. The operation of the device being the same as the operation of the devices forming the second count of case 5.

In exhibit marked Edison's Articulating Transmitter, October 1877, I desire to mention that it is not essential that the rubber should extend over the whole of the surface of the diaphragm, as the diaphragm rests at its edges upon the rubber, and is held against it by the dampening finger carrying the electrodes, the diaphragm being then dampened on both sides by rubber.

Sometime in September or October, 1877, I made an instrument which I produce.

Instrument offered in evidence and marked "Edison's three-spring Electrodes."

This instrument is substantially the same as that marked Edison's Articulating Transmitter, October 1877, with the exception that three springs made of platinum were used, between which were two cartons, the initial pressure between the platinum springs and the cartons was produced by a rubber spring tube on the diaphragm when the electrodes were brought towards it. In the model the cartons have dropped out and been lost, and the rubber tube which was once fastened to the cork on the diaphragm has become disconnected and lost.

THOMAS A. EDISON. 43

I produce a sketch made Oct. 2, 1877, by my assistant, James Adams, and signed by myself and Chas. Batchelor, which shows in the figure nearest the edge on the left hand a pointed lever adjusted by means of a screw to and from the diaphragm. The electrodes being in this case the diaphragm of the lever.

A rubber tube is placed between the lever and the bridge back of the lever for giving a forward motion, and a screw upon the right hand side passing down through the bridge to the lever, and connected therewith at its end, causes such lever to approach or recede from the diaphragm and modify the initial pressure between the electrodes.

The cork was placed upon the diaphragm and had a hole through it, in the bottom of which was a piece of platinum connected to one pole and a cup upon the lever, held the carbon which pressed upon the platinum.

My impression is that this instrument was made.

(Sketch offered in evidence and marked "Edison's Exhibit, 1-13.")

I here produce a sketch dated Oct. 3, 1877, signed by myself and witnesses by my assistant, Chas. Batchelor.

(Sketch offered in evidence and marked "Edison's Exhibit, 7-13.")

In the lower figure is shown a spring electrode resting on carbon, which in its turn rests upon the diaphragm.

The two forming 2 springy electrodes and greater or lesser initial pressure is placed upon the electrodes by means of a springy rubber tube fastened to an adjusting screw moving in and outward at right angles to the electrodes, such screw perform-

*Isbrung
Electrodes
Oct 1877.*

1-13

Oct 3. 1877

7-13

46 THOMAS A. EDISON.

ing the double function of altering the initial pressure between the electrodes and dampening the diaphragm.

The next figure above the lever one shows a lever electrode, the sketch is not very full, but my impression is, that it was pivoted at one end, and is similar to the first sketch on the top of Exhibit 36-13, except that two rubber dampening tubes were inserted between the frame comprising the diaphragm and the lever, for the purpose of dampening the lever.

47 I here produce a sketch dated Oct. 5, 1877, signed by myself and Charles Batchelor.

(Sketch offered in evidence marked
"Edison Exhibit 16-13.")

It is precisely the same as the instrument shown in Edison's Articulating Transmitter, Oct., 1877, except that instead of a hard vulcanized rubber disk, to which the spring is attached, a strip of rubber was used to hold the electrode.

The spring being quite stiff and able to sustain itself alone. It is as stiff as that shown in my application No. 178.

48 The soft rubber spring upon the diaphragm performing the same functions as if the rigid electrode was springy and the soft rubber tube rigid.

In this device shown on Exhibit 16-13, we have two electrodes, between which is the carbon as in my application No. 178.

One, the electrode towards the diaphragm, consists of a spring, upon the ends of which is a disk of metal, this disk resting on carbon, which carbon rests on the other electrode, which is rigid, that is to say, it is not springy. This is not the case with the electrode in application No. 178, but the soft rubber tube upon the dia-

THOMAS A. EDISON. 49

phragm renders it unnecessary to have the other electrode springy.

Were this rigid electrode springy then the soft rubber tube might be dispensed with.

The initial pressure in both this and Application No. 78 is produced in substantially the same manner.

I think one instrument like Exhibit 7-13 was made as an experiment.

I think several instruments were made like 16-13.

These were made within a few days after the date of the exhibits.

I here produce a sketch made Oct. 4, 1877, signed 50 by myself and Chas. Batchelor.

(Sketch offered in evidence, and marked
"Edison's Exhibit 9-13.")

The bottom figure shows the diaphragm as one electrode, and a lever resting on the diaphragm as the other electrode.

The initial pressure between the electrodes is regulated by means of a rubber on its extreme end, adjustable inward and outward at right angles to the lever.

In the upper figure shown in Exhibit 9-13 two dampening fingers are shown, which consist of two screws with rubber spring tubes at their ends, which tubes rest upon the diaphragm.

The screws being adjustable inwardly or outwardly, produce a dampening effect upon the diaphragm.

The following words are written upon the sketch when it was made:

"Extra screws and rubbers to dampen the diaphragm."

Both instruments described in the sketch were

9-13

62 THOMAS A. EDISON.

made within a few days after Oct. 4, 1877, and tested, and they worked.

I here produce a sketch, dated September 21, 1877, signed by myself and Chas. Batchelor.

164-12

Sketch offered in evidence, marked "Edison's Exhibit 164-12."

At the bottom of the sheet is a sketch marked "Damped Diaphragm." The following words written at the time are on that exhibit:

Amperer
works beautifully

"Mic diaphragm loose and laid against a stretched rubber diaphragm; this prevents the effect of expansion and kills harmonics, both low and high; it works beautifully. We made a lot of telephones this way; and they all showed that it did the biz, hunky-dory?"

I here produce a sketch dated November 5, 1877, signed by myself and James Adams.

57-13

(Sketch offered in evidence and marked "Edison's Exhibit, 64-13.")

The figure at the top shows two spring electrodes, between which is a piece of carbon.

Motion and pressure was given to the electrodes by means of the diaphragm.

The initial pressure between the two electrodes being brought about by means of a screw.

The sketch shown is a mere outline to convey to one of my assistants the idea to be carried out on an instrument already made, and similar to that called Edison's Articulating Transmitter, October, 1877.

I will now proceed to make a sketch which will more fully explain the one made November 5, 1877.

THOMAS A. EDISON. 55

(Sketch produced in evidence and marked "Edison's Exhibit, 54-13, additional.")

54-13
additional

This corresponds with the second count in case No. 5.

The instrument was made and put in use probably within a few days from the date on the exhibit.

Examination adjourned to Saturday, October 9th, 1880, at 10 o'clock A. M.

S. L. G.,
Notary.

MEXLO PARK, NEW JERSEY.
Saturday, Oct. 9, 1880. }

Met pursuant to adjournment.
Same parties present.

Examination adjourned by consent until Saturday, October 16, 1880, at 10 o'clock A. M.

S. L. G.,
Notary.

Examination adjourned by consent to Thursday, October 28, 1880, at 10 o'clock A. M.

S. L. G.,
Notary.

MEXLO PARK, NEW JERSEY. }
Thursday, Oct. 28, 1880. }

Met pursuant to adjournment.

Present—L. W. Serrell, Esq., on behalf of T. A. Edison; W. W. Swan, Esq., and J. J. Storrow, Esq., on behalf of R. L. Wilson and F. Blake, Jr.

Continuation of examination of Mr. T. A. Edison, by L. W. Serrell, Esq.

Q. Counsel for Edison offers in evidence a copy

Eng Pat 2909
has
damping like
Crompton 45, 6 & 13

Fig 11. B²

69 A. Fig. 11 corresponds to the encl. P, in which the subject matter is: "The spring carrying the electrode covered with rubber, or similar elastic material," inasmuch as the object of this soft material is to prevent the spring itself from vibrating to its proper musical tone, which it would do were not means provided whereby these vibrations were damped.

If the spring be combined with a soft substance, such as rubber, these vibrations are checked, and not transmitted.

In the early stages of my experimenting, soon after I devised the instrument shown in my patent 2909, the vibration of the springs used in that instrument caused us considerable trouble by sending false vibrations over the wire.

60 These vibrations were soon afterwards prevented to a great extent by putting cotton around the springs, marked "P" in said patent, and serving with thread; also rubber tubes were used, mottos boxes were also poured over the springs.

The device shown in figure 11 of my British patent No. 2,909 consists of an electrode spring in the form of a letter U, with a damping material "r" between the prongs of the same, and at the place where the greatest vibration would take them.

Another object accomplished by this U spring was to present a somewhat flexible or giving con-

duct point, so as to prevent a rebound of the diaphragm.

A band of wire was used to bind the two prongs against the damping rubber r, which was afterwards changed for a band of rubber wound several times around the U shaped spring.

This was done about June or July, 1877.

In relation to the claims regarding the damping of the diaphragm to prevent false vibrations, I will say that in figure 2, of British patent 2,909, the diaphragm was loose, and the ear was the damper as it was held against it in the act of receiving.

That in figure 16 the diaphragm was damped by the electrode, and the same is the case with figure 9, 10, 23, 24 and 25.

That regarding the rubber around the diaphragm that patent states that "in some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm so as to check, or dampen any prolonged or false vibration and render the sound more clear and free from prolonged tones."

This is shown in fig. 18, but the reference in the specification to that figure, seems to have been left out.

I here produce the original of fig. 11, in my British Patent, 2909, without the band around the fork which was afterwards added; this sketch is dated June 27, 1877, signed by myself and witnessed by Charles Batchelor and James Adams.

The drawing and writing was made at the same time and the device I think was made within a day or two after making the sketch and of the date given.

(Sketch offered in evidence and marked Edison's Exhibit 184-11.)

made June 77

Eng Patent 2909
ear damper

Fig 16 - dia
damped by
electrode

rubber damper

Fig 18.

61

184-11

*dia
made from
Dec 1877
to date*

In December, 1872, and to the present time, diaphragms have been used by me, which have been damped by dampening fingers of rubber and also diaphragms covered on both sides near its edges with rubber and with dampening fingers, besides have been used in telephones and invariably in phonographs as far as I have had knowledge of the same, sometimes the transmitter of phonograph has had only dampening fingers and others have had dampening fingers and diaphragms coated on both sides near their edge with rubber. Public exhibitions have been given with instruments made and sold from February, 1873, to the present time containing these devices.

Q. 4. Please examine the official counts in these cases and state whether or not it is your opinion that there are broader features of interference than those officially stated?

Objected to by Mr. Swan as immaterial and incompetent.

A. Yes, sir, very much broader.

Q. 5. State what devices are involved in this interference that are novel as far as you know, as between yourself, Blake and Wilson, and which could probably be secured in the future either by amendments of claims or reissue?

A. I consider that the subject matter involved in these interferences is:

1. A diaphragm resting or secured to a yielding material in any manner to prevent extra vibration being given the diaphragm by the action of the diaphragm upon the instrumentalities that hold it, — the object being to transmit only those vibrations which are in the voice, which is available either in a telephone transmitter, receiver, or a phonograph transmitter or receiver.

2. Another count, as I understand it, consists in dampening the excessive vibrations of a diaphragm — by a dampening device of whatsoever shape or arranged in any manner, which dampening device shall be of a yielding material, such as rubber. Excessive amplitude of vibration of a diaphragm causes sounds to be transmitted to the difference of tensions in the diaphragm plate itself. The dampening of the diaphragm decreases the amplitude of vibration, prevents these sounds and causes no extra sounds due to such dampening device to be transmitted, as the dampening must in all cases be of such a nature or material that the action of the diaphragm upon it will cause no vibrations to be set up other than the proper vibrations of the diaphragm itself.

3. Another count, as I understand it, consists in carrying the same principle of dampening and preventing extra vibrations into the circuit controlling electrodes which follow the vibrations of the diaphragm.

These electrodes when vibrated give extra sounds which are transmitted if proper means are not used to prevent them. This is accomplished either by employing material for making the electrodes which will not give these sounds, or by the use of metallic electrodes covered with or arranged in any proper manner with materials which will check these extra vibrations and still allow them, the electrodes, to follow the movements of the diaphragm.

4. Another count is the use of springs or any yielding device to hold the diaphragm in its place.

5. Another count consists of an adjustable device, whether spring or lever, upon which the two electrodes of the circuit are attached, which device is adjustable by screws, or cams, or levers, or any proper mechanism, of being made to carry these electrodes

Novelty

*Point of
Novelty re-
gardless of
Counts*

to or from the diaphragm of a telephone, to the end that the initial pressure between the two electrodes can be increased to a greater or lesser degree when such electrodes are brought in contact with the diaphragm.

Other points of issue are the combinations of these various devices and details of construction.

Q. 6. Please look at the lever so called in the application of Francis Blake, marked F and the device marked I in your own application No. 178 and called a lever bar, and state whether or not they are levers, strictly speaking, and give your reasons?

A. It is not a lever but a spring. A lever is a rigid body moving on a fulcrum, and one in which energy cannot be stored up, when by itself, whereas a spring can be used to store up energy, and energy can be stored up in the arm F of Blake's application, hence it is not a lever.

71 Q. State whether or not there is any difference in the operation of the devices *I. o.* and *I.* in your application No. 178 and the devices shown in Exhibits 42-11; 106-11; 16-13; 7-13; 54-13 and 59-12 additional?

A. No, sir; the principle is the same, and in one or two instances they are mechanically the same.

72 S. Q. Why did you represent the telephone in the form shown in your application 178, instead of using the exact detailed form of some of the exhibits which you have put into this evidence?

A. Because it saved me making a model, as I found instruments being made in this form by people who I considered to be infringing my invention, and as I had made every device shown in the in that form, and as the infringement was so exact in all its details, I consider that it would be a useless expense to make the model myself when I could get one already made.

not lever but spring

as like Blake's

Blake instrument used for model

9 Q. Referring to case 6, the subject matter of which is limited to a band of rubber, or other similar elastic material applied to the disk of a telephone to cover the edge and lap upon both faces, did you ever use a band of rubber applied in this manner, and what device, if any, heretofore introduced in this case correspond with the same?

A. I have used a band of rubber on each side of a diaphragm, near the periphery, each band lapping over the edge and touching the other band, so as to form a diaphragm covered with rubber on both sides, near its edges and lapping over.

I refer to Exhibit 191-11, and to Exhibit 37-12, as illustrating this mode of using the rubber at the edges of the diaphragm.

In connection with the phonograph instrument, I have used diaphragms which rested upon one side upon a circular band of rubber, and the diaphragm held against this band of rubber and its support by a circular ring formed of soft rubber tube, introduced between the diaphragm and the mouth-piece I introduced a diagram illustrating the same.

(Sketch offered in evidence and marked "Edison's Illustration Diaphragm and Rubber Tube Damper.")

It is hereby stipulated and agreed that any testimony heretofore taken, or which shall be hereafter taken in interference cases 2 and 3, may be used in evidence in the present cases as if especially taken for the present cases.

Cross-examination by W. W. SWAN, Esq.:

10 and 11 x Q. I have here a speaking telephone, upon which is printed the mercantile or manufacturer's mark, "Edison's Carbon Telephone," and which by consent I here offer in evidence as one of my

Case 6

used two lapping bands

191-11 37-12

Sketch

Stipulation Cases 2 and 3 to be used herein

Carbon telephone
one form

Client's Exhibits, to be marked "Edison's Carbon Telephone," is this the form of instrument commonly known as Edison's Carbon Telephone?

A. It is one of the forms.

xQ. 12. Can you tell about how many speaking telephones of this pattern which I have now produced, have been made and put in use?

A. No, sir, I cannot, but I think there are several thousand.

(The telephone referred to in question 11 and 12, by consent, is put in evidence and marked "Exhibit, Edison's Carbon Telephone."

How
 some of which has been made about ~~3500~~ made, some of which has been exported.

xQ13. Can you tell about how many has been made since the first of January, 1880?

A. Only from information and belief, I think, perhaps, nearly all were made previous to that time.

xQ14. I would like to know about how many had been made the 1st of January, 1879, and about how many had been manufactured each month during the year 1879?

A. It is impossible for me to say, as I have had nothing to do with the manufacture of these instruments, all my rights having been sold to the Western Union Telegraph Company; my statements I might make regarding the number manufactured, would be on information and belief.

xQ15. When did you sell all your rights to the Western Union Telegraph Co.?

A. I think I agreed to sell all my rights to the Western Union Telegraph Company about April or May, 1879.

xQ16. I wish you would give me the best estimate you can of the number of these Edison Carbon Transmitters which had been manufactured from

Agreed to sell
to W. U. May, 79

time to time during the year 1879, say quarterly during that year, and I would like also to know when the manufacture of speaking telephones of this pattern was begun?

A. I think there might have been as many as twelve or fourteen thousand telephones manufactured in 1879. I should say that there was as many as 1,500 or 1,500 made before 1879; perhaps even as many as 2,500. I should think the pattern mentioned was adopted about July or August, 1878.

xQ17. In answer to interrogatory 11, you say that Exhibit Edison's carbon telephones is "one of the forms commonly known as Edison's Carbon Telephone, what other form is so known?"

A. This transmitter has been made in several different shapes; they have not been all made exactly alike, but generally speaking this Exhibit is like the rest.

xQ18. Your Exhibit marked "Loose Diaphragm," Sept. 1877, is a magnetic receiver, is it not?

A. Yes, sir. Magnetic receiver.

xQ19. You say that you think about 100 of these instruments—"Loose Diaphragms"—were made about September, 1877—do you know where they are now?

A. Yes, I think that is the number. I think I have the major portion of them here at Menlo Park.

xQ20. You said also that about 100 or 150 transmitters, of which "Edison's Articulating Transmitter, Oct., 1877," is one, were made either in Sept., or October, 1877. Do you know where these instruments are now? I refer to the instruments like the exhibit marked "Edison's Articulating Transmitter?"

A. I think I have most of them at my laboratory at Menlo Park.

xQ21. In speaking of Edison's Articulating Transmitter, just referred to, you said, "There are

1,200 or 1,500 made
before 1879.

magnetic receiver

most at
laboratory

two electrodes with carbon between them—the one electrode towards the diaphragm is a spring, while the other is rigid”—to what part of the instrument did you refer when you used the word “spring”?

A. I referred to the electrode connected to the stud upon the vulcanized rubber disk, which stud in the exhibit is connected to a wire, which extends out from the instrument.

xQ22. Do you refer to a device which you find in Exhibit 3 spring electrodes?

A. Yes, except they are shorter.

xQ23. You refer to the 3 pieces of platinum now referring to Exhibit “Three Spring Electrodes”?

A. In the exhibit marked “Three Spring Electrodes,” the platinum springs there shown are the same as the single spring in Exhibit marked “Edison’s Articulating Transmitter,” except that one in latter is the shorter, with sufficient spring to close the circuit when not in contact with the diaphragm.

xQ24. In the course of your direct examination you produced quite a number of drawings illustrating five of and made in course of your studies and invention, in relation to telephones, have you other drawings of this general description?

A. Yes, sir; I have.

xQ25. About how many drawings have you preserved of this general description—I refer to telephones generally?

A. I should say 2,000 or 3,000.

xQ26. Have you made instruments corresponding to a large number of these two or three thousand drawings?

A. Yes, sir; I have made instruments, in trying experiments, for the major part of them.

xQ27. Nearly all of them?

A. Nearly all of them; as many as twenty experiments could be tried, by a slight alteration, in a

*Spring
electrodes*

drawings

few hours, each alteration being generally illustrated in a drawing.

xQ28. Do you mean, by the last part of your answer, that one instrument was made to answer for several drawings—that is, the main features of an instrument, having once been embodied in it, were retained, and the instrument was altered in minor details, at various times, to correspond to different drawings?

A. I mean that we had several kinds of chambers and mouth-pieces, and with these we combined therewith different devices and means for translating sound waves into electric waves. That when one of those instruments had devices upon it which made it an articulating transmitting telephone, and we desired to make an alteration, a drawing was made of such alteration, some part or parts, or everything but the mouth-piece or chamber were taken off and the new devices substituted. A drawing being made for every change, thus effecting an economy in experimenting.

xQ29. I have here a book, the title of which is as follows: The Speaking Telephone, Electric Light and other recent Electrical Inventions. By Geo. B. Prescott. With illustrations. New York: D. Appleton & Company, 1879. Will you examine the book and state whether you are acquainted with it?

A. I have seen the book.

xQ30. On page 218 I read as follows: “Chapter ‘6.—Edison’s Telephonic Researches. The following communication from Mr. Thomas A. Edison ‘gives a detailed account of his researches in telephony, and is a valuable contribution to the history of the development of the speaking telephone.’” Will you turn to the chapter referred to, and state whether or not you wrote all after the first sentence.

A. I think I wrote some of it.

Several experiments with one instrument

Prescott Book

part written by E.

31 xQ. Did you read the whole of it before it was published, and know that it was to be published as a communication from you?

A. I do not think I read the whole of it before it was published. I think I wrote a portion of it, which was afterwards changed by either the editor or his assistant. My impression is, that I furnished a certain amount of copy, and that the whole was re-written by some person unknown to me.

X Q. 32. Are there any statements in this chapter which are essentially different from the copy prepared by you, and which you furnished to the editor?

A. No; I do not think so.

X Q. 33. On page 227 of the book under consideration, I read—

"This, therefore, is the arrangement I
" have adopted in my present form
" of apparatus, which I call the car-
" bon telephone, to distinguish it
" from others; it is fully described
" in another part of this work."

To what pages of the book do you here refer?

A. I suppose it refers to pages 26, 27, 28 and 30 and 40.

X Q. 34. Chapter XV of the same book has for its heading "Edison's Recent Telephonic and Acoustic Inventions." Did you write any portion of this chapter, or communicate any portion of its contents to the editor?

A. I think the person who made the sketches from my drawings took notes and wrote the chapter himself.

X Q. 35. Took notes of what?

A. Notes descriptive of the working of the instruments illustrated in that chapter and the date of the sheet where they were illustrated.

X Q. 36. Do you mean that he took notes of explanations made by you?

A. I think he did.

X Q. 37. Where did he take these notes?

A. At my laboratory at Menlo Park.

X Q. 38. When?

Ans. I think he took them in the summer of 1878.

X Q. 39. When and where did you write your communication in Chapter VI of this book?

A. I think in February, 1878.

X Q. 40. Will you look at the cut Fig. 21, on page 30 of the book now under consideration, and state whether the telephone there represented went into commercial use, and if so, to what extent?

A. I believe there were thirty or forty of those instruments made as shown at Fig. 21, most of which were sent to Henry Bentley of Philadelphia. I think twenty-five were also sent to England and France. My impression is that they went into commercial use there.

xQ 41. Where are those instruments now?

A. I don't know.

xQ 42. In answer to Ques. 5 you stated the issues involved in these interferences. Will you refer to the Exhibits which you have introduced as a part of your testimony, and state in which the subject matter of the first count or issue as stated by you is first shown? And state the same as to each of these issues?

A. The first count, as stated in my fifth answer, is, I believe, shown, first in my Exhibit 101-11—top figure.

The subject matter of the second count, as stated in my fifth answer, is the dampening finger. I find the same to be shown on one of my drawings dated June 27, 1877.

(Counsel for Edison offers the same in evidence, and it is marked Edison's Exhibit 106-11.

*Carbon
Telephone*

*Pascott
Chap XV*

92

*50 or 40 like
Fig 21, put in
use*

93

*Ques 5
novelty as
1st Count
191-11
2 count
196-11*

04 THOMAS A. EDISON.

In this case it is applied to a receiver of a telephone.

But in Exhibit 9-13 it is applied to a transmitter for a telephone.

In the third count, as stated in my fifth answer, the first Exhibit is 184-11 and English Patent 2900, Fig. 11.

Count four, as stated in my fifth answer, is shown in Exhibit. Edison's Exhibit Articulating Transmitter, 1877.

Count five as stated in my fifth answer, is illustrated in Edison's Exhibit 112-11 in the case of ⁹⁵ Chalmers, and shown in an instrument marked Edison's Articulating Transmitter.

Cross-examination by Mr. Stinson:

xQ43. You speak in one of your answers of a loose diaphragm damped and pressed to its seat by being pressed against the ear of the listener, do you mean to include that in the class of damped diaphragms, and conclude that the fleshy part of the ear acts as a dampener?

A. It is a loose diaphragm resting upon rubber and is damped by the ear or by the finger, and as far as the principle is concerned it meets the count.

xQ44. And if there were no rubber in that case would you or would you not consider such an arrangement to be a diaphragm dampener?

A. Yes, sir.

xQ45. Is the English int. 2900 put in by you the first of your English patents that relate to telephones?

A. Yes, to a speaking telephone.

xQ46. I observe that the provisional specification of that patent was filed July 30, 1877. Can you tell me when it was prepared?

A. I think the notes for the provisional specification were written out sometime in June.

THOMAS A. EDISON.

07

xQ47. I notice that the final specification purports to have been signed by you Dec. 24, 1877. Can you tell me how long before that it was prepared?

A. I should say about three or four weeks.

xQ48. What was your next English patent relating to telephones?

A. English patent on phonographs 1244 of 21th April, 1878. The next English patent is No. 280 of 15th June, 1878, is on telephones and apparatus employed in electric circuits.

xQ49. Which of your exhibits in evidence in cases 1 to and B. 3 most closely resembles the drawing in your application No. 178?

A. The Exhibit marked Edison's Articulating Transmitter.

(It is agreed that the book by Prescott referred to in this evidence may be referred to at the hearing without repeating the same in the record.)

Redirected by Mr. SERRILL.

R D Q. 50. Have you since your evidence was first given in these cases discovered any additional matters that you desire to introduce in evidence?

A. Yes. I have discovered one drawing which I here produce it has relation to the fifth division of invention as I have defined it in my fifth answer. It is dated May 25, 1877, signed by myself and witnessed by James Adams and Charles Batchelor.

Drawing offered in evidence marked Edison's Exhibit 90-11.

R D Q. 51. Please state how this instrument operates, and if any such device was constructed?

A. It operates in a similar manner to my Exhibit 42 11, in the case of Chalmers, with the exception that

(Count 5 ans)
184-11
Eng Pat 2900
4th Count

5 Count
112-11

finger or ear
mette count

Eng Pat
2376

98

Edison's articulating
Trans. most like
Case 178

Prescott book
put in evidence

00

99-11.

100 THOMAS A. EDISON.

2 Count case 5
Spring made
May 1877
Caseat 76

special adjusting screws are provided for the two springs carrying the electrodes to regulate the pressure upon the carbon and the electrode against the diaphragm, as set forth in the 2d count in the official statement of case 5.

I had such an instrument made about May 25, 1877. The instrument worked fairly.

In my Patent No. 76, filed March 8, 1878, fig. 42, two springs are shown with the electrode between them, and a spring between the same and the diaphragm.

101

Counsel for Edison here gives authority to counsel for Blake & Wilson to refer to said Patent and to obtain a copy of said fig. and to so much of the description as refers thereto.

Caseat 77
March 1878

In Patent on Phonograph No. 77, filed in March, 1878, in figure 15 a diaphragm is shown with rubber rings at each side near its edge.

I also discover the diaphragm of a telephone I made on the 20th of March, 1877, in which there is a lever retracted by a spring, and adjusted by a screw, and having a second spring, the circuits being connected to the spring and lever respectively, and the spring intervening between the lever and the diaphragm.

Four sets of lever springs and diaphragms are shown. By this means the two circuit electrodes were made to approach and recede from the diaphragm in the same manner as in my application No. 75.

An apparatus like that was made, and my intention was to send it to the Patent Office, and apply for a patent on the same, but I cannot find that I have done so.

(Counsel for Mr. Edison offers the same in evidence, and it is marked Edison's Exhibit, 30-11.)

THOMAS A. EDISON.

30-11

CHARLES BATCHELOR.

102

It is stipulated and agreed that the testimony taken in behalf of T. A. Edison in this case shall be in the possession of Geo. T. Pinckney, Notary Public, for printing and proof-reading, and that the original paper exhibits shall be photolithographed, and that the model exhibits shall be represented by drawings, and that the photolithographs and drawings shall be received at the hearing with the same effect as the originals, and that the original model and paper exhibits shall be in the custody of L. W. Serrell, counsel for Edison, to be produced by him at the hearing, if called for, and at any other time at reasonable notice.

S. L. G.,
Notary.

LABORATORY OF T. A. EDISON,
 Menlo Park, New Jersey.

Thursday, October 28, 1880.

CHARLES BATCHELOR, a witness called in behalf of T. A. Edison in the above named interference, being duly sworn, deposes and says, in answer to interrogatories propounded by L. W. Serrell, Esq., counsel for T. A. Edison, as follows:

1st Q. Please state name, age, residence and occupation?

A. Charles Batchelor, age 36, residence Menlo Park, assistant to T. A. Edison.

2d Q. How long have you been acting as assistant for Mr. Edison: and state whether or not you have aided him in his telephone experiments?

A. I have been Mr. Edison's assistant for the last ten years, and have been through all, nearly all, his experiments in telephony.

3d Q. I will now read to you the subject matter involved in the interference cases between Edison, Blake & Wilson, and known in cases 4, 5, 6 and B. 3, and ask you, whether Mr. Edison has ever made

Stipulations
about
Exhibits

104

105

Counts

any telephones containing the subject matter of said interferences?

A. Yes, sir, he has.

5 Q. Please look at Edison's Exhibit 191-11, and state what the upper figure thereon shows, if you know?

A. The drawing referred to represents a diaphragm with rubber rings on each side of it, on each side of its edge. Such an instrument was made by myself or Jas. Adams, about the time of the date of this drawing.

6 Q. Please give the date of the drawing and state whether or not your signature is on the same, and whether or not the drawing is in the same condition as it was when originally made, with the exception of the notary's mark, "Edison's Exhibit 191-11, S. L. G. 1?"

A. The date on the drawing is June 26th, 1877; my name is upon the drawing, and it is in the same condition, to the best of my belief, as when made, with the exception referred to. I put my signature on it about the date marked on the drawing.

7 Q. Please state whether the telephone instrument that you have referred to with the rubber rings on each side of the diaphragm, was ever made use of, and if so, with what result?

A. The instrument worked well.

8 Q. What was the object of the rubber rings?

A. To increase the amplitude of the vibration of the diaphragm, and also to deaden the metallic harmonic vibration.

9 Q. About what time was this instrument made and used?

A. Shortly after the date of the drawing, viz.: June 26, 1877.

10 Q. Please look at the drawing, "Edison's Exhibit 37-12," and state whether your signature is on the same, when the drawing was made, and what it shows?

A. My signature is on the same. I signed it about July 26, 1877, and it shows a number of different shaped diaphragms and bands on diaphragms of rubber. It also shows a diaphragm placed between rubber rings, one at the edge of the diaphragm. Also three small drawings illustrative of these rings, in order to instruct more fully the experimenter who made it. These three drawings are marked, one as the outside ring, another as the inside ring, and the middle, the diaphragm; it also gives further instructions in writing, which says, "put rubber or other soft substance rings between diaphragm on the rings."

11 Q. Please state whether or not a telephone instrument was made with the devices shown upon "Exhibit 37-12," and, if so, about when, and whether or not there are several forms of diaphragms and rubber illustrated on said "Exhibit 37-12."

A. Telephone instruments were made, I believe, similar to all shown in these drawings, and many more, about the time of the date of this drawing, July 26, 1877. There are several forms of diaphragm and rubber illustrated. In the four upper figures the rubber is shown as a complete disc, upon which the diaphragm portion rested. In the device shown, the rubber was simply in the form of rings, the diaphragm being between them.

12 Q. Please refer to "Edison's Exhibit 164-12," and state whether you signed the same, and when, and whether or not it is in the same condition as it was when you signed it, and what the same represents?

A. I signed that about Sept. 21, 1877. It is in the same condition, I believe, as when I signed it, except the addition of the Notary's mark in the left hand lower corner. This mark is, Edison's Exhibit 164-12, S. L. G. This drawing shows a base diaphragm,

instrument made July 26, 1877

164-12

191-11

37-12

resting on a stretched diaphragm of rubber to be used in a telephone.

13Q. Please examine the telephone instruments marked "Edison's Articulating Transmitter, October, 1877, S. L. G.," and "Edison's Three-spring Electrodes, S. L. G.," and state whether you ever saw the same before, and, if so, about when?

A. The instrument marked "Edison's Articulating Transmitter, October, 1877," is one of a number of instruments made on the principle marked in "Edison's Exhibit 104-12." A number of these were made about the date of the drawing marked "Edison's Exhibit 104-12."

113 son's Exhibit 104-12." I recognize this instrument as one of the original ones, and, as far as I can see, is in the same condition as when made, with exception of the case enclosing the back. This Exhibit, marked "Edison's Exhibit Three-spring Electrodes," I recognize as an experiment tried by Mr. Edison, about October, 1877. It is not in the condition as originally made, as I see the rubber diaphragm has broken away and only the edge around where it is fastened remains. The carbon buttons also, I see, are gone. I remember this instrument.

14Q. Please examine Edison's Articulating Transmitter, and state whether or not this subject matter of the counts in Case 4, and the first one in Case 5, are contained therein?

A. They are.

15Q. Please examine "Edison's Exhibit 106-19," and state whether that is your signature when the same as applied, and whether or not any change has been made in the same since it was signed by you?

A. That is my signature, and the sheet is the same as when I put my name on it, about August 12, 1877, with the exception of the notary's mark, Edison's Exhibit 100-19, S. L. G.

16Q. Was any instrument made, and if so, when,

*rubber broken
carbon button
gone*

Counts 4 & 5

*Articulating
transmitter*

in the form illustrated by the middle figure, and described in the statement: "Soft Rubber to Deaden the Diaphragm. It works well, prevents harmonics or excessive vibrations."

A. Yes, sir, such an instrument was made, and the soft rubber was applied to the diaphragm by stretching two strips of it across the face of the diaphragm; one a little above and the other a little below the centre. This instrument was made August 12, 1877, and worked well.

17Q. Was any other form device proposed for clamping the diaphragm besides the strips of rubber?

A. Yes, sir; in connection with this instrument, Mr. Edison proposed and wrote out the following: "Hard pieces of rubber or equivalent material could be placed in different parts of the diaphragm, and held against it by adjusting screws to dampen it." Such a device was subsequently employed. I refer to "Edison Exhibit 9-13, S. L. G." in the upper figure of which is represented a diaphragm damped by screws and sections of rubber tube.

18Q. State whether or not your signature is on this Exhibit 9-13, and whether or not the same is in the same condition it was in originally as signed by you?

A. My signature is on this Exhibit 9-13, and was put on about October 14, 1877. The Exhibit is in the same condition as when I signed it, I believe, with the exception of the notary's mark.

19Q. Please examine the Exhibits marked "Edison's Exhibits 184-11, 186-12, 1-13, 7-13, 16-13, 30-13," and state whether or not your signature is upon each of said exhibits, the date when the same was applied, and whether or not the exhibits are in the same condition as when you signed the same, with the exception of the notary's marks, which have been put on for the purposes of this interference?

A. The exhibits are in the same condition as

*rubber words
were*

*made Aug 12
1877.*

dampener

9-13

identified

when I signed them, with the exception of the notary's marks. I signed Exhibit 184-11 about June 25, 1877; Exhibit 135-12 about August 30, 1877; Exhibit 1-13 about October 2, 1877; Exhibit 7-12 about October 4, 1877; Exhibit 16-13 about October 5, 1877; and Exhibit 20-13 about September 22, 1877.

20 Q. Please state what Exhibit 184-11 represents, and how it was used?

A. The Fig. in Exhibit 184-11 shows a spring carrying an electrode to be used in connection with a telephone diaphragm. The object of the rubber between the ends of the U shaped spring was to deaden the vibrations peculiar to the spring itself, and for this purpose there was also used about June 25, 1877, rubber rings placed around the shank of the U shaped springs. This I consider to correspond with the count in "Interference 133."

21 Q. Please state whether or not the diaphragms represented in Edison's Exhibit 135-12 were loose, so that they might be free to play under the atmospheric vibrations?

A. The two figures nearest the left hand bottom corner of this Exhibit show loose diaphragms—the higher one having a limited movement so that it would not drop off if held downwards. The lower figure shows the diaphragm resting on a ring of rubber. This diaphragm, although not shown here, was held by a spiral spring from its center inwardly. I believe it was also tried loose.

22 Q. Please look at Edison's Exhibit "Spring Finger," which drawing was made by the witness when giving his testimony, and state whether or not you ever saw a telephone instrument such as is illustrated in such Exhibit, with a loose diaphragm resting upon rubber and having spring fingers to hold it to its seat?

A. I remember such an instrument, such as shown

in "Edison's Exhibit, August 1, 1877," and believe it was made about August, 1877.

23 Q. State whether or not that instrument was practically operated?

A. Yes, sir, it was. It was very satisfactory.

24 Q. Please look at Edison's Exhibits 1-13, 7-13, and 16-13, and state, generally, what the same represent, and whether or not any apparatus was made corresponding to the same?

A. Yes, sir; instruments were made corresponding to the middle fig. and left hand fig. in Exhibit 1-12; and instruments were made like all the devices shown on Exhibit 7-13; and instruments were made like the bottom fig. shown on Exhibit 16-13. All of these instruments were practically good talking telephones. The lower right hand fig. of Exhibit 7-13 shows an instrument in which the diaphragm holds in its center one electrode, whilst the other electrode is fastened to a spring on which a rubber tube is pressing. In this case there are two springs; the diaphragm also forms a spring, which would correspond with the second count of Case 9.

The screw for adjustment being equivalent to the lever spoken of in said count. The device shown in Exhibit 16-13 I also consider to correspond with the same count. In some instances Mr. Edison made use of a lever instead of an adjusting screw, as shown in "Exhibits 30-14," and also in the left hand figure "Exhibit 11-13."

25 Q. Please state whether or not any instrument was made corresponding to Edison's "Exhibit 20-13?"

A. Yes, sir. An instrument was made similar to the lower figure. I remember seeing the instrument quite recently, but cannot say my hand upon it at this moment.

26 Q. Please examine the exhibit marked "Edison Exhibit, Loose Diaphragm, Sept., 1877," and state whether or not the same is one of the original in-

Satisfactory

good inst.

count case 5

lever & screw

184-11

in B2

135-12

loose dia

Spring finger

made

Aug 1877

struments containing the loose diaphragm, and about when the same was made?

A. The instrument marked "Elli-son's Musical Telephone" is one of the original instruments, and was made about Sept., 1877. I believe.

27 Q. Please refer to the instrument marked "Elli-son's Musical Telephone, Sep., 1877, and state whether you ever saw the same before;—when it was made, and the manner in which the diaphragm is held in place?

A. I have seen the instrument before, and I believe it was made about Sept., 1877. The diaphragm is held in place with rubber rings on each side, near the outer edges.

Cross-examination by W. W. SWAN, Esq.:

23 x Q. Will you state, if you know, how these drawings, concerning which you testified in your direct examination, came to be made?

A. Previous to the making of an instrument, or experiment, Mr. Edison frequently made such drawings as a guide to his assistants to show them better what he wanted than he could do so in words.

29 x Q. Have you witnessed a large number of such drawings?

A. Yes, sir, I have.

30 x Q. Mr. Edison has testified in substance that he has some 2000 or 3000 drawings illustrative of his studies and inventions relating to telephones—were you aware that he had so many? How many have you probably witnessed?

A. I believe he has not overestimated the number, and I have witnessed a great many of them, and I presume all in which I was immediately interested in making the instruments from.

31 x Q. In how many of these instruments do you think you have participated in the construction?

A. I and James Adams, tried almost all the ex-

Sept. dia

Musical Telephone

*2000 or 3000
Sketches*

periments for which Mr. Edison made these drawings. They were made by ourselves and a number of other workmen, but I cannot estimate the number exactly, which we made; but I know that we tried almost all of them.

32 x Q. Did you always report the result of your experiments to Mr. Edison?

A. Mr. Edison was generally there himself, and if not there we reported to him anything of consequence that resulted from the experiments carried on during his absence.

33 x Q. How recently have you looked over this great mass of drawings?

A. I looked over part of them some time ago—perhaps six weeks.

34 x Q. Are you able to explain the different instruments for which the drawings were respectively made?

A. Yes, sir. I presume nearly all of them.

35 x Q. Over how long a period do these drawings extend. During what period of time were they made?

A. From about the middle of 1876 till the present time, very few having been participated in by me, however, since in 1879, I should say. Since that time Mr. Edison has had me engaged in electric light experiments, principally.

36 x Q. Do you think that Mr. Edison made some 2000 or 3000 of those drawings referring to telephones before you became principally engaged in electric light experiments?

A. The majority of them was made before that time.

CHAS. BATCHELOR.

tried most of them

Can explain nearly all the instruments

Drawings from middle of 76

130 State of New Jersey, }
County of Middlesex, } ss:

At Menlo Park, in said county, on the 8th and 28th days of October, A. D., 1880, before me personally appeared the above-named Thomas A. Edison and Charles Batchelor, and made oath that the foregoing depositions by them subscribed contain the truth, the whole truth, and nothing but the truth. The said depositions are taken at the request of Thomas A. Edison, at the time and place named in the notice hereto attached, to be used upon the hearing of an interference between the claims of the said Thomas A. Edison and those of E. L. Wilson and Francis Blake, Jr., before the Commissioner of

131 Patents on the 26th day of December, A. D., 1880. The said E. L. Wilson and Francis Blake, Jr., were duly notified, as appears by the original notice hereto annexed, and attended by W. W. Swan, Esq., and J. J. Storrows, Esq., their counsel. And I further certify that the said witnesses were duly sworn before commencing their testimony, and that the testimony was subscribed by them in my presence. That the deposition of Mr. T. A. Edison was written out by George T. Pinckney, and that the deposition of Mr. Charles Batchelor was written out by Dr. Otto Moses, most of it in my presence, and that I am not connected by blood or marriage with either of the parties to this interference, and 132 am not interested directly or indirectly in the matter in controversy.

Witness my signature and Notarial
seal this 28th day of October, 1880.

S. L. GRIFFIN,
Notary.

[Notarial Seal.]

TELEPHONE INTERFERENCES, 4, 5, 6, 1P.

133

By consent, Mr. Edison, being re-called, testifies as follows:

In further illustration of the invention referred to my direct examination in-chief, I produce sketch 111-11, May 20, 1877, marked Edison's Exhibit 111-11, S. L. G., it was made by me, on or before the date affixed to it. The memoranda on it are in my handwriting, and it is signed by me, and by Charles Batchelor and James Adams.

THOS. A. EDISON.

DECEMBER 9th, 1880.

This may be attested by the notary to Mr. Edison's deposition, and stands as part of his testimony. 134

J. J. STORROWS.

For Blake & Wilson.

L. W. SERRELL,

Att'y for Edison.

DECEMBER 9, 1880.

In the foregoing interferences, cases 4, 5, 6, and B*, it is hereby consented that the record of T. A. Edison, taken in cases 2 and 3, to which Messrs. Chittcock, Edison and Blake are parties, and the record of said Edison in case 1, to which Messrs. Voelkers, Edison and Blake are parties, may be referred to, by either party hereto, with the same effect as if such evidence had been specially taken in the present cases. 135

W. W. SWAN,
Att'y for Blake, and for Wilson.
LEMOUEL W. SERRELL,
Att'y for T. A. Edison.

Telephone Interferences [Volume 8]

Edison v. Dolbear v. Anders

The argument for Edison has been filmed.

Prof. J. A. Edison

BURGONE (Telephone No. 500), 29 Ross St.

INTERFERENCE ON TELEPHONES.

THOS. A. EDISON,
AMOS E. DOLBEAR,
GEORGE L. ANDERS.

Argument for Thomas A. Edison.

MAY IT PLEASE YOUR HONOR:

This is one of those cases where there are three contestants, two of them, Anders and Dolbear, have both been about equally diligent, and the dates of the two parties are pretty clearly established, and Anders did nothing before May 3, 1879; while Dolbear claims to go back to April. I am justified in considering the contest as between Edison and Dolbear, and as substantially disregarding Anders as a claimant. However, first I must call your Honor's attention to the defective and experimental character of Anders' device, so that it may not escape attention.

Anders had a disk, and upon it an arm with a string to a diaphragm; he proposed to have three electro-magnates revolving close to this disk, and when the current passed through the helices the attraction of the cores for the disk varied, and there was more or less power exerted thereby to draw upon the string to the diaphragm. The instrument brought to Mr. Hayes (fol. 21) had only one helix; now it is impossible for this to act uniformly, because the leverage would vary according to the position this magnet stood in to the arm and string. It appears that two of the three helices were re-

moved before being sent to the Patent Office, and Mr. Anders stated, but I do not see it in the evidence, that one helix worked better than the three; and concerning the utterly useless and experimental character of the Anders' instrument, it is only necessary to consider his cross-examination, folios 10 to 13, which are as follows:

16 x-Int. How many instruments like that shown in your application for a patent have you ever made?

A. Only one.

17 x-Int. Where is that instrument now?

A. In the Patent Office, at Washington, I believe.

18 x-Int. Did you ever try that instrument to see whether it could be operated at all?

A. I did.

19 x-Int. When, and with what success?

A. Immediately on its completion I experimented some few days. I found that an increase and decrease of current produced the result I desired.

20 x-Int. Did you endeavor to receive articulate speech?

A. I did.

21 x-Int. With what success?

A. With no great success?

22 x-Int. Could you distinguish each word spoken, or could you only distinguish that a person was speaking, without hearing all the words?

A. Well, as I said before, the articulation was not good, but I could distinguish the disturbance in the diaphragm when used as a receiver. I concluded the telephonic current must be much more powerful than that which I used, and some of the details changed.

23 x-Int. Have you had a general knowledge of the progress made from time to time in telephonic instruments?

A. I have; I have followed them as closely as possible.

24 x-Int. When did you first know of the Edison motophone, patented March 31, 1879, No. 221,957?

A. The principle involved in that was first shown to me by Edison himself, I think in 1873 or 1874—at least before he removed from Newark. I think possibly I may have heard of his motophone previous to May 6, 1879, but I am not sure. The principle involved in it I had been acquainted with some time before.

On the part of Dolbear it is contended that he made the invention in April, 1879. In May, 1879, he read a paper before the Academy of Science describing the device; in this he acknowledges that he knew of the Edison motophone, patented November 25, 1879, No. 221,979, applied for March 31, 1879, referred to in the evidence and made part hereof; the varying friction produced by electricity acting between a chalk cylinder and an arm from the diaphragm are clearly set forth. Now, your Honor will see, by comparison of this patent with the pretended invention of Dolbear, that there is not a particle of difference either in the construction or operation, except that magnetism takes the place of electric decomposition. In other words, in both cases there is a diaphragm and a revolving surface, and friction induced by electric action, is the means for moving the diaphragm. In one case the friction resulting from the action of the electric current is varied by electrolysis; in the other instance, by magnetism. Both these forces were well known. Edison had before patented his motograph (No. 153,787, Jan. 19, 1875), in which he sets forth his discovery of friction being varied by electrolysis, and the action of magnetism to increase friction had long since become a well known property of matter.

Under these circumstances, Dolbear gave nothing to the public, and if he had been the first inventor of the special device, which he was not, he would deserve no credit, because Edison had given the

whole subject to the world in his patent, No. 221,057, and there was nothing left for Dolbear to do, but as both parties have claimed the modification of the Edison motophone, Your Honor is properly called on to decide the question of priority.

The application of Anders was first in the Patent Office September 12, 1879. Dolbear was next, November 7, 1879, and Edison last, viz.: December 31, 1879.

As all three parties were in the Patent Office within four months of each other, and within eight months of Dolbear's conception, it is contended that the dates of application are not of the least importance.

Edison produces evidence, that cannot be doubted, that in August of 1876, he had combined all the devices that go to make up the instrument in question, but the diaphragm; he had the revolving shaft as the core of the electro-magnet, he had the helix in which the current was pulsed, he had the arm resting on the revolving magnetized core, and the arm gave motion to a yielding body. That yielding body, however, was a relay-lever instead of a diaphragm.

It appears by the evidence that early in 1879, before Charles P. Edison went to Europe, that the precise device in question was made by Charles P. Edison, and that articulate speech was received upon the instruments he made: C. P. Edison went to Europe early in the spring of 1879, and died there, and the evidence is clear by Upton (46), Batchelor (51) and Edison (24, 28, &c.) that the instruments were made as early as February, 1879. This clearly establishes Edison as the prior inventor because,

1st. His motophone patented Nov. 25, 1879, and known of by Dolbear, accomplishes the same object by electrolysis instead of magnetism, the parts and mode of operation corresponding.

2d. The magnetic action and the variation of friction by magnetism, the revolution of the core and motion derived therefrom were invented

by Edison in 1876, and the record is clearly established, and Dolbear (fol.11) admits, that the mode of operation would be the same in a sounder.

3d. Edison did actually make the device in question before Dolbear or Anders, viz.: in February, 1879, and the instrument operated, and Dolbear did nothing until April 14, 1879, and Anders did nothing until May 6, 1879.

Edison explains the delay between his invention and application by showing that he was endeavoring to make the motophone more perfect. The Exhibit 160-14 demonstrates that Edison had gone further than Dolbear ever thought of when he introduced the induction coil in the line at the transmitter.

Batchelor's evidence that the talking was distinct but low (50) is conclusive on the question of the operative character of the instruments made by Charles P. Edison, and the whole record is one that clearly shows that every feature in controversy was invented and practically operative before Dolbear had done anything.

The question of abandonment or unreasonable neglect cannot arise under any circumstances, because Edison's application was made within about ten months from the time he made the first instrument and he was adding thereto and developing the details up to within about three or four months from the time of his application.

There is not the most remote evidence or even suggestion that Edison knew anything about Dolbear's experiments, and on the contrary Dolbear knew of Edison's motophone, hence the presumption is in favor of Edison's independent efforts and against Dolbear, for his own paper, read before the Academy of Science, shows Dolbear sought to accomplish what Edison had done by analogous means.

There is no evidence that the device of Dolbear is in any respect better than that which Edison had on

the market; Dolbear admits he had never made any comparison between his device and the Edison motophone, and no person sustains his statements concerning the operation of his instruments, and because he made three or four instruments, that gives him no better standing than though he had made only one or two.

Your Honor's attention may be called to the fact that the revolving shaft may be magnetized and that the current in the helix serves to augment or neutralize this magnetism; this is a well known feature in every polarized magnet, and the same feature is shown in connection with the upper figure in Exhibit 322—8, where the arms are polarized and the revolving core also has its polarity, and Batchelor (fol. 55) refers to both electro magnets and permanent magnets having been used, and Edison (fol. 42), states positively that one instrument made by C. P. Edison for him had a permanent magnetized core; Edison is, therefore, clearly the prior inventor on this point.

Mr. Anders, it is understood, has substantially withdrawn from the contest, and it appears that Mr. Dolbear is not the prior inventor of any of the devices in controversy, and that on the contrary, he was only copying the devices of Edison, some, at least, of which he knew of before doing anything, and that Edison had made and used the devices in controversy before Dolbear commenced to experiment; therefore, it is believed that a decision in favor of my client, Edison, is only a matter of right.

Respectfully submitted,

LEMUEL W. SERRELL,
Attorney for T. A. Edison.

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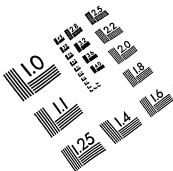
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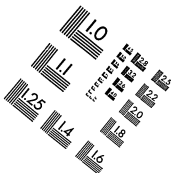
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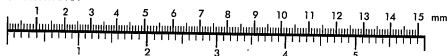


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